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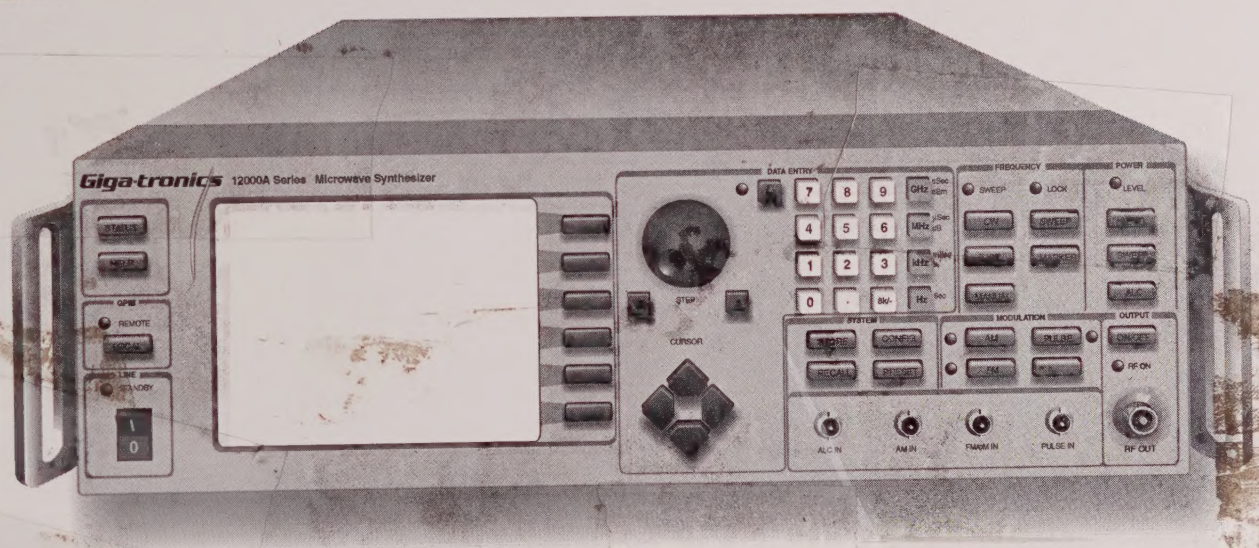


Series 12000A Microwave Synthesizers

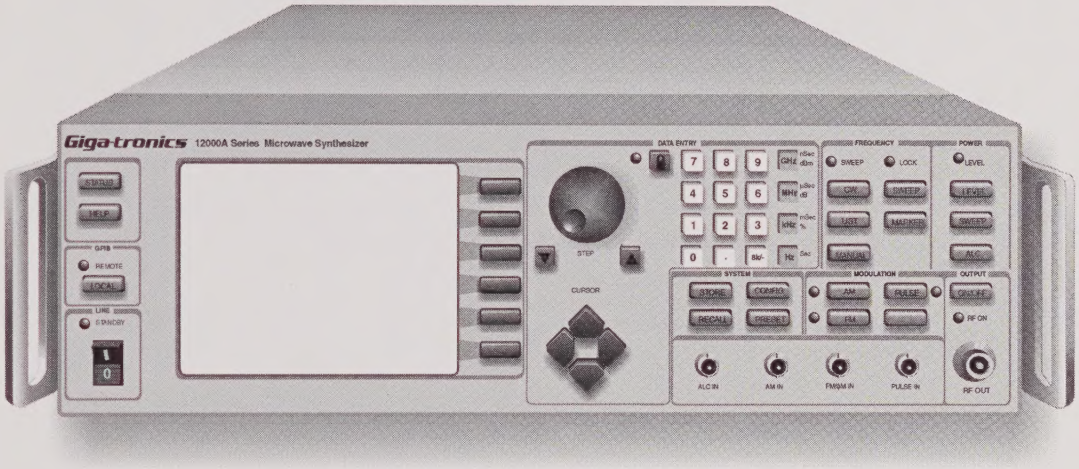
Operation Manual

553

12000A

Giga-tronics

P/N: 31231
Revision: D
Print Date: April 2001



Series 12000A Microwave Synthesizers

Operation Manual

12000A

CE.....Certified Product **ISO 9001**..... Certified Process
Registrar: BSI, Certification No. FM 34226 ❖ Registered 04 June 1996 ❖ Amended 01 March 2000

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WARRANTY

Giga-tronics Series 12000A instruments are warranted against defective materials and workmanship for three years from date of shipment. Giga-tronics will at its option repair or replace products that are proven defective during the warranty period. This warranty DOES NOT cover damage resulting from improper use, nor workmanship other than Giga-tronics service. There is no implied warranty of fitness for a particular purpose, nor is Giga-tronics liable for any consequential damages. Specification and price change privileges are reserved by Giga-tronics.

Model Numbers

The series 12000A has model numbers for each instrument with a specific frequency range as described in Chapter 1. All models are referred to in this manual by the general term 12000A, except where it is necessary to make a distinction between the models. In these cases, the specific model number(s) will be used.

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Technical Publication Change Instructions

Updated replacement pages and/or drawings are attached to these Change Instructions. Please remove and discard the corresponding pages and/or drawings, and replace them with the attached pages and/or drawings. Failure to make these replacements may result in loss of product efficiency and possible failure.

Page numbers no longer have an alpha suffix, the revision level will now have a numerical suffix denoting its difference. Specific changes are identified by change bars in corresponding margins. A replacement page with no suffix has not been changed but is included only because it is part of the changed page.

Replacement pages will become standard pages without a suffix in the next printing of this manual and the Front Matter, Table of Contents, Preface and Index will be updated at that point. For record purposes, you are encouraged to retain these change instructions as a permanent part of the manual. Record new changes in your manual section entitled "Record of Changes".

Product:	12000A	**Manual:**	SERIES 12000A MICROWAVE SYNTHESIZERS OPERATION MANUAL	
Errata Issued:	August 6, 2001	**Errata #:**	31231-E1	
Manual P/N:	**Manual Revision:**	**Print Date:**	**New Manual Revision:**	**Errata Print Date:**
31231	E	July 2001	E1	August 2001

Update your product technical manual. Replace the page(s) indicated below with their new revision level:

ECO(s):	**Replace Page(s):**	**Remark(s):**
7757	Entirety of Chapter 1	Changes facilitated by ECO 7757 incorporating an entire update to Chapter 1. The Performance Specifications and General Specifications have been updated significantly.
N/A	2-9 thru 2-10	This change was made to correct an update in the manual. It has no connection to ECO 7757.

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1 Introduction

1.1 General Information

1.1.1 Introduction

The 12000A is a microwave synthesizer with step, ramp and list sweep capability; it operates over a wide range of microwave frequencies and power levels, and in a variety of modulation modes. The 12000A can generate output signals over a frequency range of 10 MHz to 20 GHz; the frequency range is dependent on the specific model number (see below). The RF output can be fixed (CW), step, ramp or list sweep with external frequency, amplitude, or pulse modulation.

Installation instructions are in Section 1.2. Performance specifications are in Section 1.3. Operation from the instrument front panel is detailed in Chapter 2. Instructions on how to operate the instrument from a remote host computer over the General Purpose Interface Bus are in Chapter 3.

The following are the 12000A model numbers with their respective frequency range:

Table 1-1: 12000A Model Numbers

CW, Step, and List Sweep	CW, Step, Ramp, and List Sweeps	Frequency Range
Model 12508A	Model 12708A	10 MHz to 8 GHz
Model 12528A	Model 12728A	2 GHz to 8 GHz
Model 12520A	Model 12720A	10 MHz to 20 GHz
Model 12522A	Model 12722A	2 GHz to 20 GHz

1.1.2 Features

- Advanced digital processing architecture, driving a high-speed, ferrite-based YIG oscillator
- Spectrally pure output with a tuning resolution of 0.1 Hz
- Optimum oscillator fast switching speed while maintaining low phase noise
- Field-programmable gate arrays perform logic operations quickly while a digital signal processor functions as a secondary processor for dynamic control and fast frequency settings without burdening the primary processor
- The frequency ramp sweep technique provides an analog-like ramp sweep using a high-speed digital step sweep of the synthesizer between pre-defined start and stop frequencies. Linearity errors are virtually eliminated because the frequency is stepped at a faster rate than the PLL bandwidth, essentially producing a swept phase locked loop

1.1.3 Environmental Standards

The 12000A is environmentally tested for compliance with MIL-PRF-28800F, Class 3.

1.1.4 Items Furnished

Accessories and options are detailed in Appendix B to this manual. In addition to options and/or accessories specifically ordered, the following items are furnished with the instrument:

- Operation Manual, P/N 31231
- Power cord (6-ft.), P/N WMPO-03007

1.1.5 Items Required

An IEEE 488 interface cable is needed for remote control operation. Appropriate RF output cabling made to fit the female type SMA output connector can be ordered as an Accessory Cable Kit, No. A001. No special tools are required to operate the 12000A. Test equipment required for calibration or performance verification is described in Chapter 4.

1.1.6 Cooling

A cooling fan is installed in the instrument. The cooling air intake is located on the rear panel. Care must be taken to avoid obstructing the flow of air into the instrument.

1.1.7 Cleaning

The air intake screen should be cleaned whenever a significant amount of dust has accumulated on it. Whenever the instrument covers are removed, the interior should be blown out with dry air at a low velocity.

1.1.8 Preparation for Reshipment

If it is necessary to return the instrument to the factory, protect the instrument during reshipment by using the best packaging materials available. If possible, use the original shipping container. If the original container is not available, use a strong carton (350 lbs./sq.in. bursting strength) or a wooden box. Wrap the instrument in heavy paper or plastic before placing it in the shipping container. Completely fill the areas on all sides of the instrument with packaging material. Take extra precaution to protect the front and rear panels. Seal the package with strong tape or metal bands. Mark the outside of the package: **"FRAGILE — DELICATE INSTRUMENT"**.

If corresponding with the factory or the local Giga-tronics sales office regarding reshipment, please provide the model and serial number. If the instrument is being returned for repair, be sure to enclose all relevant information regarding the problem that has been found.

NOTE: *If you are returning an instrument to Giga-tronics for service, first contact Customer Service so that a return authorization number (RMA) can be assigned via e-mail at* ***repairs@gigatronics.com*** *or at* ***800.444.2878*** *(The 800 number is only valid within the US). You may also try our domestic line at* ***925.328.4650*** *or Fax at* ***925.328.4702****.*

1.2 Installation

The instrument is shipped in operational condition and no special installation procedures are required. A warm-up time of 20 minutes is recommended for normal operation (see Chapter 4 for warm-up time prior to calibration and testing). Each Giga-tronics instrument must pass rigorous inspections and tests prior to shipment. Following installation, the performance of the 12000A should be checked immediately to insure that operation has not been impaired during shipment. Performance verification procedures are detailed in Chapter 4.

1.2.1 Rear Panel Interface

This section defines the functions and interface of the rear panel (see Figure 1-1). Some connectors are duplicates of those on the front panel (see Figure 2-2 for an illustration of the front panel). The RF Out connector will be installed on the front panel unless the instrument includes Option 22, which relocates the connector to the rear panel (see Figure 1-1).

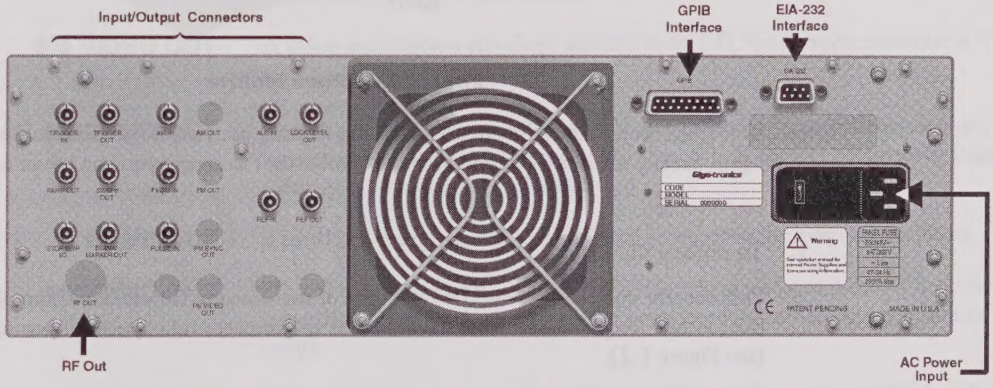

Figure 1-1: 12000A Rear Panel

1.2.1.1 Line Voltage

The 12000A contains primary and standby power supplies with internal switching. The instrument automatically senses the input line voltage in the range of 90 to 253 Vac, 47 to 64 Hz (400 Hz optional). There are no manual voltage adjustments or selection controls. The 12000A has a 3-wire power cord with a 3-terminal polarized plug for connection to the power source and safety ground.

The power cord cannot be longer than 3 meters (9 feet) to meet safety requirements.

WARNING

The safety ground is connected directly to the chassis. If a 3-to-2 wire adapter is to be used, be sure to connect the ground lead from the adapter to earth ground. Failure to do this could cause the instrument to float above ground, posing a shock hazard.

CAUTION

DO NOT position the equipment so that it is difficult to operate the disconnecting device (to remove the AC line cord).

1.2.1.2 Line Fuse

The 12000A has a line fuse container on the rear panel.

1.2.1.3 Fuse Installation

The power line fuse is a 2A, Slo-Blo, 250V, Type T (see Figure 1-2 for location).

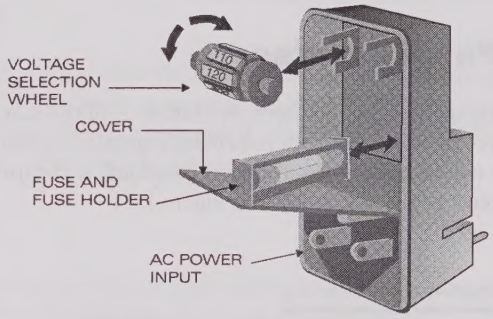

Figure 1-2: Fuse Holder

The fuse holder is contained in the covered housing directly above the AC power connector on the rear panel. To gain access, use a small screwdriver or similar tool to snap open the cover and proceed as follows:

1. **To replace the fuse:**

   Pull out the small drawer on the right side of the housing (marked with an arrow) and remove the old fuse. Replace with a new fuse, insert the drawer and close the housing cover (see Figure 1-2).

1.2.2 Connectors

1.2.2.1 Rear Panel I/O Connectors

REF OUT A buffered square wave output at 10 MHz, 2 V_{P-P} minimum into 50 Ω, derived from the internal or external timebase.

REF IN An external timebase input signal, 5 or 10 MHz $\pm 1 \times 10^{-6}$ or better, 0.5 to 5 V_{P-P}, overrides the internal time base. Input impedance is 100 Ω nominal.

STOP SWP I/O A TTL-compatible input/output (low input stops a sweep; low output indicates that a sweep has been stopped).

LOCK/LEVEL OUT A TTL-compatible output (high indicates the output frequency is phase locked and the output power is leveled).

ALC IN An input signal for remote leveling control of output power by positive or negative polarity ZBS detectors, or by applicable power meters (duplicates the front panel ALC IN connector).

PM VIDEO OUT A pulse modulation envelope waveform at TTL level, approximately 4 V_{P-P} into 50 Ω (Option 24 only).

BLANK/MKR OUT A sweep related output: +5 V or -5 V during band changes, filter changes, and sweep retrace; 0 V during sweep; +5 V or -5 V at marker frequencies (signal polarity is software controlled).

RAMP OUT 0 to +10 V ramp output, proportional to progress between sweep limits.

PM SYNC OUT 50 ns wide trigger pulse output at TTL levels (approximately 4 V into 50 Ω), coincident with leading edge of the pulse modulation envelope (Option 24 only).

TRIGGER IN This connector accepts a sweep trigger input ≥ 50 ns wide at TTL level to initiate a sweep or step.

TRIGGER OUT This connector accepts a sweep trigger output coincedent with the frequency step ending the event.

AM OUT An amplitude modulation waveform output at ~2 V_{P-P} into 10 kΩ (Option 24 only).

0.5V/GHz OUT An output voltage directly proportional to the RF output frequency.

PULSE IN PM input signal for external pulse modulation (duplicates the front panel PULSE IN connector).

FM OUT A frequency modulation waveform output at ~2 V_{P-P} into 10 kΩ (Option 24 only).

AM IN This connector accepts the input signal from a 600 Ω external amplitude modulation source (duplicates the front panel AM IN connector).

FM/ΦFM IN This connector accepts the input signal from a 50 Ω external frequency or phase modulation source (duplicates the front panel FMΦFM IN connector).

RF Out This is the instrument's RF output signal on a type SMA (f) connector. It replaces the RF Out connector on the front panel when the instrument is configured for Option 22 (see Appendix B for the details of Option 22).

1.2.2.2 Front Panel I/O Connectors

Refer to Figure 2-17 in Chapter 2 for an illustration of these connectors.

ALC IN An input signal for remote leveling control of output power by positive or negative polarity ZBS detectors, or by applicable power meters (duplicates the rear panel ALC IN connector).

AM IN This connector accepts the input signal from a 600 Ω external amplitude modulation source (duplicates the rear panel AM IN connector).

FM/ΦFM IN This connector accepts the input signal from a 50 Ω external frequency or phase modulation source (duplicates the rear panel FMΦFM IN connector).

PULSE IN This connector accepts the input signal from a 50 Ω external pulse modulation source (duplicates the rear panel PULSE IN connector).

RF Out This is the instrument's RF output on a type SMA (f) connector located on the front panel. (Option 22 for rear panel location).

1.2.2.3 Interface Connectors

GPIB IEEE 488.2 interface connection (24-pin) between the 12000A and host computer equipment for remote operation over the General Purpose Interface Bus (GPIB). The connector pin assignments are listed in Table 1-2.

Table 1-2: IEEE 488.2 Hardware Configurations

Pin	Signal	Pin	Signal	Pin	Signal
1	D101	9	IFC	17	REN
2	D102	10	SRQ	18	GND (6)
3	D103	11	ATN	19	GND (7)
4	D104	12	Shield	20	GND (8)
5	EO1	13	D105	21	GND (9)
6	DAV	14	D106	22	GND (10)
7	NRFD	15	D107	23	GND (11)
8	NDAC	16	D108	24	GND Logic

EIA-232 This 9-pin connector interfaces communications equipment using RS-232 format. See Table 1-3 for the connector pin assignments.

Table 1-3: EIA-232 Pin Assignments

Pin	Function
1	Protective Ground
2	Transmitted Data
3	Received Data
4	Request To Send
5	Clear To Send
6	Data Set Ready
7	Signal Ground
8	Carrier Detect
9	Reserved for modem testing

1.3 Performance Specifications

RF Signal Performance & Operational Modes

1.3.1 CW Operation

1.3.1.1 Range

0.01 to 8 GHz

2 to 8 GHz

0.01 to 20 GHz

2 to 20 GHz

1.3.1.2 Resolution

0.1 Hz (Standard)

1 kHz (Optional)

1.3.1.3 Accuracy & Stability

Identical to time base oscillator

1.3.1.3.1 Time Base (Internal)

10 MHz

1.3.1.3.2 Aging Rate

$<1 \times 10^{-9}$/day after 72 hours continuous oven operation

$<5 \times 10^{-10}$/day with Option 28

1.3.1.3.3 Temperature Stability

$<\pm 2 \times 10^{-10}$/ °C (0 to +55°C)

1.3.1.3.4 Time Base (External)

5 or 10 MHz ($\pm 1 \times 10^{-6}$ or better) (Software selected)

0.5 to 5 V_{P-P} into 100 Ω (Nominal)

1.3.1.3.5 Switching Time, List Mode

<500 µs to within 1 kHz of set frequency (Typical)

1.3.1.3.6 Switching Time, CW Mode

35 ms to within 1 KHz of set frequency (Includes IEEE overhead) (Typical)

1.3.1.3.7 Residual FM During Switching

Refer to FM Table in section 1.3.9.1.2, Wide Mode Residual Column

1.3.1.4 RF Output

1.3.1.4.1 Maximum Leveled Output (0 to 35°C)

Frequency Range (GHz)	Standard (dBm)	Option 26 (dBm)
0.01 to 2	+15 dBm	+14 dBm
>2 to <8	+15 dBm	+15 dBm
8 to 15	+15 dBm	+13 dBm
>15 to 20	+15 dBm	+12 dBm

1.3.1.4.2 Incremental Level Range

-20 to +20 dBm

1.3.1.4.3 Resolution

0.01 dB, entry and display

1.3.1.4.4 Minimum Calibrated Output Level

-120 dBm with attenuator option

-10 dBm without attenuator option

RF Off

Attenuates the output to <-140 dBm at the output connector

1.3.1.4.5 Flatness

±0.5 dB (-10 dBm to maximum specified power) at 25 ±10°C (Internally Leveled, CW or Frequency Step or Ramp Mode)

Add ±0.1dB/10 dB with attenuator option (±2.5 dB with Opt. 20)

At 35 to 55°C, maximum output power is +13 dBm, flatness +/- 1 dB

Typical temperature coefficient is -0.025 dB per degree C

1.3.1.4.6 Accuracy

Add 0.2 dB to Flatness (Internally Leveled, CW, Frequency Step, or Ramp Mode)

1.3.1.4.7 Maximum Slope of Level Variation

<0.5 dB/MHz

1.3.1.4.8 Output Switching Time

<500 µs; 20 ms with attenuator change

1.3.1.4.9 Output Impedance

50 Ω, nominal

1.3.1.4.10 Output SWR

<2.0:1 (Typical)

1.3.1.4.11 Level Drift

<0.05 dB/hour. Max 0.1 dB/24 hours

1.3.1.5 Spectral Purity

1.3.1.5.1 Harmonics

Frequency (GHz)	Harmonic (dBc)	Power (dBm)
0.01 to 0.10	-30	+6
>0.10 to 2	-50	+6
>2 to 20	-60	+6

1.3.1.5.2 Subharmonics

None

0.01 to 2 GHz

-60 dBc >2 GHz

A subharmonic is defined as any ¼, ½, or ¾ multiple of the fundamental RF Output

1.3.1.5.3 Nonharmonics

<-60 dBc from 0.01 to 16 GHz

<-55 dBc from >16 to 20 GHz

1.3.1.5.4 Single-Sideband Phase Noise

dBc/Hz, CW mode, all power levels:

Freq.(GHz)	Offset from Carrier				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
0.25	-101	-101	-109	-122	-129
0.5	-95	-95	-103	-122	-124
2	-87	-92	-94	-120	-125
4	-81	-86	-88	-110	-130
6	-81	-84	-85	-110	-130
8	-75	-80	-82	-105	-130
10	-75	-80	-82	-105	-125
18	-69	-75	-75	-100	-120
20	-69	-75	-75	-100	-120

1.3.1.5.5 Residual FM

Hz, RMS, CW Mode:

Frequency Range (GHz)	Post Detection Bandwidth (Hz)	
	300 to 3000	50 to 15000
<2 GHz	Decreases by ½ per oct	Decreases by ½ per oct
2 to <4	<6	<35
4 to <8	<12	<70
8 to <16	<24	<140
16 to 20	<32	<200

1.3.1.5.6 AM Noise

<- 130 dB/Hz from 0.01 to 2 GHz

<-145 dBm/Hz @ >2 GHz

1.3.1.6 Ramp Frequency Sweep

A continuous sweep is generated within the instrument. The continuous sweep may be operated simultaneously with digital power sweep.

1.3.1.6.1 Sweep Type

Smooth frequency ramp progression sweep

Sweep Direction

Either up or down in frequency

1.3.1.6.2 Sweep Ramp Shape

Linear frequency ramp with respect to time

1.3.1.6.3 Sweep Range

From the minimum frequency to the maximum frequency of the instrument, as configured

1.3.1.6.4 Start Frequency Accuracy

Phase locked to time base (via YIG tune coil)

1.3.1.6.5 Stop Frequency Accuracy

Phase locked to time base (via YIG tune coil)

1.3.1.6.6 Halted Frequency Accuracy

Phase locked to time base via YIG main tune coil

1.3.1.6.7 Start & Stop Freq. Resolution

0.1 Hz standard (1 kHz, Opt. 36)

1.3.1.6.8 Minimum Sweep Width

100 Hz standard (1 MHz, Opt. 36)

1.3.1.6.9 Maximum Sweep Width

From the minimum frequency to the maximum. Frequency of the 12000A as configured.

1.3.1.6.10 Sweep Width Resolution

0.1 Hz (1 kHz, Opt. 36)

1.3.1.6.11 Sweep Time

1 ms to 200 sec

1.3.1.6.12 Sweep Time Resolution

10 µs

1.3.1.6.13 Minimum Sweep Rate

100 kHz/sec

1.3.1.6.14 Maximum Sweep Rate

8 ms/octave

1.3.1.6.15 Sweep Linearity

Better than 0.03% of sweep width relative to the 0 V to +10 V Ramp Output BNC voltage (sweep time <100 sec) (Typical)

1.3.1.6.16 Sweep Modulation Formats

AM or Pulse Modulation

1.3.1.6.17 Band Crossing Dead Time

400 µs, worst case. 200 ns, typical, filter crossing (sweep not stopped)

1.3.1.6.18 Band Crossing Locations
For .01 to 20 GHz Model

10 MHz	Band Start (no dead time here)
15.625 MHz	YIG & Filter Crossing
22.1 MHz	Filter Crossing
31.25 MHz	YIG & Filter Crossing
44.2 MHz	Filter Crossing
62.5 MHz	YIG & Filter Crossing
88.4 MHz	Filter Crossing
125 MHz	YIG & Filter Crossing
177 MHz	Filter Crossing
250 MHz	YIG & Filter Crossing
354 MHz	Filter Crossing
500 MHz	YIG & Filter Crossing
707 MHz	Filter Crossing
1 GHz	YIG & Filter Crossing
1.414 GHz	Filter Crossing
2 GHz	YIG & Filter Crossing
3.2 GHz	Filter Crossing
4 GHz	YIG Crossing
5.1 GHz	Filter Crossing
8 GHz	YIG & Filter Crossing
10.1 GHz	Filter Crossing
12.7 GHz	Filter Crossing
16 GHz	YIG & Filter Crossing
20 GHz	Band End (no dead time here)

1.3.1.6.19 0 to 10 V Ramp Output

Vout = (10 V) |(fout - fstart)| / |(fstop - fstart)|(frequency ramp sweep mode)

Vout = (10 V) |(Pout - Pstart)| / |(Pstop - Pstart)|(power ramp sweep mode)

Vout = 0 to 10 V ramp @ current set sweep rate (ramp during CW mode)

1.3.1.6.20 0.5 / GHz Output

Vout = (0.5 V) (Fout in GHz)

1.3.1.6.21 Sweep Modes

Start/Stop

FA ≤ [F1 ≠ F2] < FB
Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2)

Start/Δ

FA ≤ [F1 ± ΔF] ≤ FB
Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF)

CTR/Δ

FA ≤ [CF ± (ΔF/2)] ≤ FB
Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF)

Δ MKR

FA ≤ [Mx ≠ My] ≤ FB
Sweeps up or down from any preset marker (Mx) to any other preset marker (My)

1.3.1.6.22 Sweep Functions

Auto

Continuous recycle of the preset sweep

Single

A single cycle of the preset sweep initiated by manual operation of the front panel push-button or reception of the corresponding GPIB command

EXT

A single cycle of reset sweep initiated by a trigger from an external source

Manual

Stops the sweep when activated by the front panel push-button, the assertion of the Stop Sweep I/O BNC or the reception of the corresponding GPIB command to allow manual tuning of the frequency to any point in the sweep. Allows continuation of the current frequency

1.3.1.6.23 Frequency Markers

Twelve intensity, video, and/or amplitude markers, individually selected from either the front panel or via the GPIB

Resolution

Sweep width/4000

Accuracy

Same as Sweep linearity except the marker may vary ±25 mV relative to the linear 0 to +10 V RAMP OUT

Amplitude Markers

A -10 to +10 dB change in RF output during analog frequency sweep

Video Markers

TTL level output or ±5 V

Intensity Markers

Provides a timed dwell of frequency sweep

1.3.1.7 Step Frequency Sweep

1.3.1.7.1 Range

FA (minimum frequency of instrument) to FB (maximum frequency of instrument)

1.3.1.7.2 Step Size

Any increment within the frequency resolution

1.3.1.7.3 Dwell Time

May be set in 1 ms increments from approximately 1 ms to 200 sec

Setup Time

200 µs (Typical)

1.3.1.7.4 Accuracy & Stability

Same as in CW when locked at each step during dwell time

1.3.1.7.5 Modes

Start/Stop

$FA \leq [F1 \neq F2] \leq FB$
Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2)

Start/Δ

$FA \leq [F1 \pm \Delta F] \leq FB$
Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF)

CTR/Δ

FA ≤ [CF ± (ΔF/2)] ≤ FB
Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF)

Start/Steps

FA ≤ [F1 ± (Step Size × Number of Steps)] ≤ FB
Sweeps up or down from a preset start frequency (F1) through a preset number of frequency steps

1.3.1.7.6 Functions

Auto

Continuous cycle of the preset sweep

Single

A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by the manual operation of the front panel push-button or reception of the corresponding GPIB command

EXT

A single cycle of the preset sweep initiated by each trigger from an external source

EXT Step

A single step of a preset step sweep initiated by each trigger input from an external source

Manual

Stops the sweep when activated by the front panel push-button, the assertion of the Stop Sweep I/O BNC or reception of the corresponding GPIB command to allow manual tuning of the frequency to any point in the sweep. Allows continuation from the current frequency

1.3.1.8 Ramp Power Sweep

Continuous sweep, self generated within the instrument. Can be operated simultaneously with digital frequency sweep.

1.3.1.8.1 Range

-10 dBm to maximum power, up or down (-120 dBm is maximum power with Opt. 26)

1.3.1.8.2 Sweep Time
(Any Sweep Mode)

2 ms to 200 sec in five ranges. Minimum sweep time is determined by the sweep width and the maximum sweep speed

Minimum Sweep Width

.01 dB

Maximum Sweep Speed

1 dB/ms

Range	Resolution
2 ms to 20 ms	10 µs
20 ms to 200 ms	100 µs
200 ms to 2 sec	1 ms
2 sec to 20 sec	10 ms
20 sec to 200 sec	100 ms

1.3.1.8.3 Sweep Level Resolution
(Any Sweep Mode)

0.01 dB

1.3.1.8.4 Start Level Accuracy
(Any Sweep Mode)

Add 0.2 dB to Flatness

1.3.1.8.5 Sweep Level Linearity
(Any Sweep Mode)

±0.25 dB

1.3.1.8.6 Sweep Modes

Start/Stop

LA ≤ [L1 ≠ L2] ≤ LB
Sweeps up or down from a preset start level (L1) to a preset stop level (L2)

Start/Δ

LA ≤ [L1 ± ΔL] ≤ LB
Sweeps up or down from a preset start level (L1) through a preset sweep width (ΔL)

CTR/Δ

LA ≤ [CL ± (ΔL/2)] ≤ LB
Sweeps up or down through a preset sweep width (ΔL) centered symmetrically about a preset center level (CL)

1.3.1.8.7 Sweep Functions

Auto

Continuous recycle of preset sweep

Single

A single cycle of the preset sweep, initiated by manual operation of the front panel push-button or reception of the corresponding GPIB command

EXT

A single cycle of the preset sweep, initiated by a trigger input from an external source

Manual

Stops the sweep when activated by the front panel push-button, the assertion of the Stop Sweep I/O BNC or the reception of the corresponding GPIB command to allow manual setting of the level to any point in the sweep. Allows continuation of the current level

1.3.1.9 Step Power Sweep

1.3.1.9.1 Range

LA (minimum level of instrument) to LB (maximum level of instrument)

1.3.1.9.2 Step Size

Any increment within the instrument's level resolution

1.3.1.9.3 Dwell Time

May be set in 1 ms increments from approximately 1 ms to 200 sec

1.3.1.9.4 Setup Time/Step

100 µs (Typical)

1.3.1.9.5 Accuracy & Stability

Same as in CW when leveled at each step during dwell time

1.3.1.9.6 Modes

Start/Stop

$LA \leq [L1 \neq L2] \leq LB$
Sweeps up or down from a preset start level (L1) to a preset stop level (L2)

Start/Δ

$LA \leq [L1 \pm \Delta L] \leq LB$
Sweeps up or down from a preset start level (L1) through a preset sweep width (ΔL)

CTR/Δ

$LA \leq [CL \pm (\Delta L/2)] \leq LB$
Sweeps up or down through a preset sweep width (ΔL) centered symmetrically about a preset center level (CL)

Start/Steps

$LA \leq [L1 \pm (\text{step size} \times \text{number of steps})] \leq LB$
Sweeps up or down from a preset start level (L1) through a preset number of level steps

1.3.1.9.7 Functions

Auto

Continuous recycle of the preset sweep

Single

A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by manual operation of the front panel push-button or receipt of the corresponding GPIB command

Ext

A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by a trigger input from an external source

Manual

Stops the sweep when activated by the front panel push-button, the assertion of the Stop Sweep I/O BNC or the reception of the corresponding GPIB command to allow manual setting of the level to any point in the sweep. Allows continuation from the current level

Modulation Parameters & Operational Modes

AM, FM, Pulse and Scan Modulation driven by external waveforms is standard on all models. Option 24 provides two function generators for internally generated amplitude and frequency modulation envelope waveforms. A pulse generator is also provided.

1.3.2 Pulse/Square Wave Modulation (PM)

Specifications apply with Scan/AM and FM off. PM may be operated with FM and/or Scan.

1.3.2.1 PM Basic Operation

1.3.2.1.1 On/Off Ratio

>80 dB

1.3.2.1.2 Rise/Fall Times

Rise Time	Frequency Range
<10 ns	>500 MHz
<50 ns	>64 to 500 MHz
<350 ns	25 to 64 MHz
<500 ns	<25 MHz

1.3.2.1.3 Overshoot, Undershoot and Ringing

<10%, >500 MHz

1.3.2.1.4 Settling Time (to within 1 dB)

<75 ns (for pulses >75 ns)

1.3.2.1.5 Leveled Pulsed Output Power Accuracy (Ref. to CW Output Power) at 25 ±10°C

±0.5 dB, ≥100 ns pulse width

±1 dB pulse width, between 100 ns and 75 ns (Typical - Requires a typical setup time of 100 µs after initial setting)

1.3.2.1.6 Typical Setting Time for a Series of Leveled Pulses

100 µs

Demand Pulse Polarity

RF will be on with TTL level demand pulse at Pulse Modulation Input BNC either at high or low logic level, selectable

1.3.2.1.7 Time Between Start of Demand Pulse (Video In) and Start of RF Pulse

<50 ns

1.3.2.1.8 Minimum Required RF OFF Time Between Pulses

100 ns

1.3.2.1.9 Delivered Minimum Pulse Widths

Minimum Width	Frequency Range
20 ns	>500 MHz
100 ns	64 to 500 MHz
1 µs	<64 MHz

1.3.3 Internally Generated PM Envelope

See specifications for Option 24 - Modulation Function Generator Module.

1.3.4 Pulse Delay (Referenced to Sync Output)

1.3.4.1 Range

0 to 1.5 sec

1.3.4.2 Resolution

10 ns

1.3.4.3 Accuracy

±1% of setting ±20 ns, whichever is greater

1.3.4.4 Jitter

±0.01% of setting ±100 ps, whichever is greater

1.3.5 Pulse Width

1.3.5.1 Range

50 ns to 1.5 sec

1.3.5.2 Resolution

10 ns

1.3.5.3 Accuracy

±1% of setting ±20 ns, whichever is greater

±0.01% of setting ±100 ps, whichever is greater

1.3.6 Externally Triggered PM Envelope

One PM Envelope produced by each trigger.

1.3.6.1 Repetition Rate

5 Hz to 5 MHz

1.3.6.2 Pulse Delay

Set by internal delay control

1.3.6.3 Pulse Width

Set by internal width control

1.3.6.4 Input Trigger Required

Positive or Negative-going TTL Level Trigger Pulse, >20 ns wide

1.3.7 Externally Generated PM Envelope

One envelope produced by each pulse.

1.3.7.1 Repetition Rate

5 Hz to 5 MHz, leveled

DC to 10 MHz, unleveled

1.3.7.2 Pulse Offset Delay
(Output Envelope Leading Edge Referenced to Input Pulse Leading Edge)

50 ns (Typical)

1.3.7.3 Input Pulse Required

Positive or Negative-going TTL Voltage Level Trigger Pulse, ≥75 ns wide (leveled output); ≥20 ns wide (unleveled output). Pulse must be able to drive a 50 Ω load

1.3.7.4 Pulse Width

Defined by external pulse width

1.3.8 Scan Modulation

Scan may be operated simultaneously with FM and/or PM. Specifications apply with FM and PM off.

1.3.8.1 Envelope Parameters

1.3.8.1.1 Frequency of Operation

0.01 to 20 GHz

1.3.8.2 Scan Mode

1.3.8.2.1 Range

0 to 60 dB, ≥ +10 dBm

1.3.8.2.2 Resolution

0.1 dB

1.3.8.2.3 Sensitivity

-10 dB/volt in 1 dB increments

1.3.8.2.4 Step Response

<1 µs for 50 dB change; <10 µs, <1 GHz

1.3.8.2.5 Frequency Response

DC to 150 kHz, sine wave

1.3.8.2.6 Input Impedance

600 Ω (Nominal)

1.3.8.2.7 Accuracy

±0.25 dB plus +/- 5% of depth in dB (For .01 to 2 GHz, specification applies only up to 30 dB)

Linearity

±0.6 dB (0 - 20 dB), ±1 dB (20 - 60 dB)

1.3.8.3 Internally Generated Scan/AM Envelope

See Specifications for Option 24.

1.3.9 Frequency Modulation (FM)

Specifications apply with Scan/AM and PM off. FM may be operated simultaneously with Scan/Linear AM and/or PM (PM & Linear AM not allowed simultaneously).

1.3.9.1 Wide Mode Envelope Parameters

1.3.9.1.1 Wide Mode

Max Deviation

See table on next page

Minimum Deviation

10 kHz at 4 - 8 GHz (other ranges proportional)

Modulation Resolution

1 kHz (deviation <1 MHz); 10 kHz (deviation >1 MHz) (at 4 - 8 GHz other ranges proportional)

Flatness

±2 dB for rates from 100 Hz to 1 MHz; ±3 dB to 8 MHz

Residual FM

See table on next page

Modulation Accuracy

±5% at maximum deviation, 1 kHz modulation rate

Distortion

<5% (±1 MHz deviation)

Incidental AM

±0.2% / MHz of deviation

1.3.9.1.2 Narrow Mode Envelope Parameters

Max Deviation

See table on next page

Modulation Resolution

10 Hz (deviation <10 kHz); 1 kHz (deviation >10 kHz) (at 4 - 8 GHz other ranges proportional)

Flatness

±2 dB for rates from DC to 1 MHz

±3 dB for 1 MHz to 8 MHz

Residual FM

Same as CW

Modulation Accuracy

+5% at maximum deviation,1 kHz modulation rate

Distortion

<5% (±1 MHz deviation)

<1% @ 10 KHz (4 to 8 range)

Incidental AM

±0.2% / MHz of deviation

Frequency (GHz)	Max Wide Deviation (Pk)	Max Narrow Deviation (Pk)	Wide Mode Resid. FM
.010 to .016	40 kHz	2 kHz	<200 Hz
>.016 to .032	80 kHz	4 kHz	<200 Hz
>.032 to .064	160 kHz	8 kHz	<200 Hz
>.064 to .125	320 kHz	16 kHz	<200 Hz
>.125 to .25	640 kHz	32 kHz	<200 Hz
>.25 to .5	1.25 MHz	64 kHz	<200 Hz
>.5 - 1	2.5 MHz	125 kHz	<375 Hz
>1 - 2	5 MHz	250 kHz	<750 Hz
>2 - 4	10 MHz	.5 MHz	<1.5 kHz
>4 - 8	20 MHz	1 MHz	<3 kHz
>8 - 16	40 MHz	2 MHz	<6 kHz
>6 - 20	80 MHz	4 MHz	<12 kHz

1.3.9.2 Internally Generated FM Envelope

See Specifications for Option 24.

1.3.9.3 Externally Supplied FM Envelope

1.3.9.3.1 Waveform

Any waveform compatible with bandwidth considerations

1.3.9.3.2 Rate

DC to 8 MHz

1.3.9.3.3 Input Sensitivity, Settable

1 V_{p-p} for maximum Peak deviation (FM deviation control set to maximum)

1.3.9.3.4 Input Impedance

50 Ω (Nominal)

1.3.10 Amplitude Modulation (AM)

AM may be operated simultaneously with FM. AM Specifications apply with FM turned off.

1.3.10.1 AM Envelope Parameters

1.3.10.1.1 Modulation Depth

0 to 90% @ 0 dBm output power

1.3.10.1.2 Modulation Resolution

1%

1.3.10.1.3 Modulation Bandwidth

DC to 150 kHz, ±3 dB @ 0 dBm output

1.3.10.1.4 Modulation Accuracy

±10% of depth setting (e.g. A setting of 50% may be within a 40% to 60% reading)

1.3.10.2 Externally Supplied AM Envelope

1.3.10.2.1 Waveform

Any waveform compatible with bandwidth considerations

1.3.10.2.2 Input Sensitivity
(AM Depth Control Set to 100%)

1 V_{p-p}, for 50% depth ±10% depth @ 1 kHz modulation rate

1.3.10.2.3 Input Impedance

600 Ω (Nominal)

1.3.10.3 Internally Generated AM Envelope

See Specifications for Option 24.

Inputs/Outputs

All connectors are type BNC unless otherwise stated.

1.3.11 Front Panel

1.3.11.1 RF OUT

Generator's RF output signal on type SMA connector

1.3.11.1.1 Opt. 22

Moves the RF output connector to the rear panel

1.3.11.1.2 Opt. 23

For Type N connector

1.3.11.2 AM IN

Input signal for external amplitude modulation (see section 1.3.10.2)

1.3.11.3 FM IN

Input signal for external frequency modulation (see section 1.3.9.3)

1.3.11.4 PM IN

Input signal for external pulse modulation (see sections 1.3.6 & 1.3.7)

1.3.11.5 ALC IN

Signal input for remote leveling of output power by positive or negative polarity ZBS detectors or by applicable power meters

1.3.11.5.1 Range

500 μV to 2 V

1.3.11.5.2 Loop Bandwidth

50 kHz (Nominal) (ZBS detector)

0.7 Hz (Nominal) (Power meter)

1.3.11.5.3 Input Impedance

10 k Ω (Nominal)

1.3.12 Rear Panel

1.3.12.1 REF IN

External time base input signal, 5 or 10 MHz ±1 X 10^{-6} or better, 0.5 to 5 V_{p-p} overrides internal time base. Input impedance is 100 Ω (Nominal)

1.3.12.2 REF OUT

Buffered time base output, 2 V_{p-p}, into 50 Ω, derived from internal or external time base

1.3.12.3 STOP SWEEP IN/OUT

TTL level signal, low input to stop frequency sweep or output to indicate that sweep has been stopped

1.3.12.4 LOCK/LEVEL OUT

TTL high indicating that frequency is phase-locked and output power is leveled

1.3.12.5 PM VIDEO OUT

TTL level (approximately 1 V into 50 Ω) pulse modulation envelope waveform (Opt. 24)

1.3.12.6 PM SYNC OUT

TTL level (approximately 1 V into 50 Ω), 50 ns wide trigger pulse out coincident with leading edge of pulse modulation envelope waveform (Opt. 24)

1.3.12.7 AM SIG OUT

2 V_{p-p}, into 1 M Ω, amplitude modulation waveform output

1.3.12.8 FM SIG OUT

2 V_{p-p}, into 1 M Ω, frequency modulation waveform output

1.3.12.9 BLANK/MARKER OUT

±5 V during band change, filter change and retrace, 0 V during sweep, and ±5 V during markers. Signal polarity software selectable

1.3.12.10 0.5 V/GHz OUT

Signal directly proportional to the output frequency

1.3.12.11 TRIGGER IN (SWEEP)

TTL level, ≥50 ns wide trigger input to initiate sweep or step

1.3.12.12 RAMP OUT

0 to +10 V ramp out, proportional to frequency between set sweep limits

1.3.12.13 TRIGGER OUT (SWEEP)

Trigger output coincedent with the frequency step ending the event

1.3.12.14 AM IN

Input signal for external amplitude modulation

1.3.12.15 FM/ϕFM IN

Input signal for external frequency modulation

1.3.12.16 PULSE IN

PM input signal for external pulse modulation

1.4 General Specifications

1.4.1 Remote Interfaces

1.4.1.1 GPIB

IEEE STD 488.2 (GPIB), all parameters except AC power on/off

1.4.1.2 Serial

EIA RS-232 Serial Interface DB9 connector

1.4.2 Operating Temperature

0 to 55°C

1.4.3 Environmental

Complies with MIL-PRF-28800F, Class 3

1.4.4 Approvals

CE marked

1.4.5 Power

90 - 253 VAC

47 - 64 Hz (400 Hz optional)

150 Watts (Nominal)

1.4.6 Fuse Rating

2 A, SB

1.4.7 Weight & Dimensions

Item	Benchtop Model	Packed for Air Shipment
Width	16.75 in. (42.5 cm.)	24 in. (60.9 cm.)
Depth	21 in.	21 in.
Height	5.25 in. (13.3 cm.)	11.25 in. (28.6 cm.)
Volume	1850 cuin	1850 cuin
Weight	30 lbs	40 lbs

1.4.8 Option 20 Specifications (High Power)

Specifications apply from 0° to 35°C

1.4.8.1 Output Power

+20 dBm

1.4.8.2 Flatness

+/- 2.5 dB

1.4.8.3 Harmonics

<-5 dBc from 0.01 to 0.1 GHz, <-20 dBc for 0.1 to 20.0 GHz @ +20 dBm output power

1.4.8.4 Pulse on/off

60 dBc

1.4.8.5 AM

Functional but not specified above 0 dBm

1.4.8.6 Option Activity

When the option is not active the output power is reduced by 2.0 dB

When active, the High Power Option switches in at +11 dBm

1.4.9 Option 24 Specifications

1.4.9.1 Amplitude Modulation Source

1.4.9.1.1 Waveform

Sine, square, triangle, ramp (+ or -), Gaussian Noise

1.4.9.1.2 Rate

0.01 Hz to 1 MHz, all waveforms

1.4.9.1.3 Resolution

0.01 Hz

1.4.9.1.4 Accuracy

±0.01 Hz ± Timebase

1.4.9.1.5 THD

1% (Typical)

1.4.9.1.6 AM Output

2 V_{p-p} into a 1 K Ω load

1.4.9.2 Pulse Modulation Source

1.4.9.2.1 Rate

1 Hz to 3 MHz

Rate Resolution

Range	Resolution
1 Hz to 1 kHz	1 Hz
1 kHz to 10 kHz	10 Hz
10 kHz to 100 kHz	100 Hz
100 kHz to 1 MHz	1 kHz
1 MHz to 3 MHz	10 kHz

Accuracy

±1% of range maximum value; f_m <100 KHz

±4% of range maximum value; f_m 100 KHz to <1 MHz

±10% of range maximum value; f_m >1 MHz

Jitter

Same as instrument time base

1.4.9.3 Pulse Start Variable Delay
(Referenced to Sync Output)

1.4.9.3.1 Range

0 to 1.67 seconds

1.4.9.3.2 Resolution

10 ns

1.4.9.3.3 Accuracy

±1% of setting or ±20 ns, whichever is greater

1.4.9.3.4 Jitter

±0.01% of setting or ±100 ps, whichever is greater

1.4.9.4 Pulse Width

1.4.9.4.1 Range

100 ns to 1.67 seconds

1.4.9.4.2 Resolution

10 ns

1.4.9.4.3 Accuracy

±1% of setting or ±20 ns, whichever is greater

1.4.9.4.4 Jitter

±0.01% of setting or ±100 ps, whichever is greater

1.4.9.5 Pulse Modes

Triggered, Gated, Delayed, Singlet, Doublet, Triplet, or Quadlet and Free Running

1.4.9.5.1 Interval

Range

100 ns to 1.67 seconds

Resolution

10 ns

Accuracy

±1% of setting or 20 ns, whichever is greater

Jitter

0.01% of setting or 100 ps, whichever is greater

☛ ***NOTE:*** *The interval between pulse one and pulse two, and the interval between triplets quadlets are the same. The start delay for pulse one is independent.*

1.4.9.6 Externally Triggered PM Envelope

One PM envelope produced by each trigger

1.4.9.6.1 Repetition Rate

5 Hz to 5 MHz

1.4.9.6.2 Pulse Delay

Set by internal delay control

1.4.9.6.3 Pulse Width

Set by internal width control

1.4.9.6.4 Input Trigger Required

Positive or negative-going TTL Level trigger pulse, >20 ns wide, unleveled or >75 ns wide, leveled

1.4.9.6.5 PM Sync Output

TTL levels into a 50 Ω load, 50 ns pulse coincident with start delay

1.4.9.6.6 PM Video Output

TTL levels into a 50 Ω load

10 Modulation Field

This field selects the type of modulation to be used. AM, FM, ΦM and PM are available.

AM Press **[AM]** to select amplitude modulation. AM can be linear, expressed in percent, or scan, expressed in dB with the output power being proportional to the input voltage. AM can be internal or from an external source (internal AM is available only when Option 24 is installed).

FM Press **[FM]** to select frequency modulation. FM can have a narrow bandwidth of dc to 1 MHz and a maximum deviation of 1 MHz (in the 4 to 8 GHz range), or FM can have a bandwidth of 100 Hz to 8 MHz and a maximum deviation of 20 MHz (in the 4 to 8 GHz range). FM can be internal or from an external source (internal FM is available only when Option 24 is installed).

ΦM First press **[FM]** then use the mode parameter to select phase modulation.

PM Press **[PM]** to select pulse modulation. PM can be internal or from an external source (internal PM is available only when Option 24 is installed).

11 Input Field

The Input field contains four BNC connectors. External modulation sources can be applied to the AM, FM and PM connectors (ΦM uses the FM connector). The ALC is currently not active.

12 RF Field

The RF field provides an RF connector and a switch to turn the output on and off. The adjacent LED will be ON when the RF output is turned on. The front panel RF connector will be relocated to the rear panel when Option 22 is installed.

2.3 Front Panel Applications

The remainder of this chapter presents applications examples to illustrate how to operate the 12000A by using the controls on the front panel. Only the features shown in the various menus are available (i.e., there are no other commands or command sets that can be used from the front panel). Refer to Chapter 3 in this manual if you intend to operate the 12000A over a remote interface through the General Purpose Interface Bus (GPIB) or the RS-232 serial interface.

The 12000A features a comprehensive HELP system linked to the current display. Press the **[HELP]** key to display general information about the function — this screen also provides softkeys through which you can select more detailed help topics.

Data Entry for the various menus depends on the type of entry. Parameters with numeric values can be entered and changed by the following methods:

Direct Entry

With the cursor positioned at the far left (e.g., on FREQ in the Fixed Frequency menu as shown in Figure 2-9), enter the numeric value with the keypad. The entry will display in the bottom part of the menu, and will be transferred to the Frequency line when the entry is terminated by pressing the appropriate Units key (any Units key terminates an entry that does not require units).

To enter a negative number, press the [BK/-] keypad button before entering the first digit. After the first digit has been entered, this key functions as a backspace to delete the previous digit.

Increment/Decrement

With the cursor positioned at the far left of the menu, use the knob or step button to continuously vary the numeric value of the digits on the same line with the cursor. The resolution of the steps can be changed by pressing the [*Step Size*] softkey.

Individual Digit Changes

With the cursor positioned at the far left, use the horizontal (left/right) cursor keys to highlight the digit to be changed, then use the knob or step buttons to change the value as desired. Move the cursor to the second digit to be changed and repeat the process until all digits are changed as desired. Parameters with selective values are changed by scrolling through the selections using the knob or step buttons.

Figure 2-9 is an illustration of the 12000A Fixed Frequency menu with the interactive softkeys. Press the softkey to perform the function shown in the adjacent block in the menu. The highlighted area in the display is the cursor, controlled by the cursor keys.

2.3.1 Set a CW Frequency

Press **[CW]** to generate a fixed frequency at a fixed amplitude. The menu illustrated in Figure 2-9 will display, showing the current or last-used frequency. In addition to changing frequencies in this menu,

DECLARATION OF CONFORMITY

Application of Council Directive(s)

Standard(s) to which Conformity is Declared:

89/336/EEC and 73/23/EEC	EMC Directive and Low Voltage Directive
IEC 1010-1:1990 + A1: 1992 Modified: 1995 + A2	Safety
EN61326-1 (1997)	EMC

Manufacturer's Name:
Giga-tronics Incorporated

Manufacturer's Address:
4650 Norris Canyon Road
San Ramon, California 94583
U.S.A.

Type of Equipment:
Microwave Synthesizer

Model Series Number:
12000A

Model Number(s) in Series:
12508A, 12520A, 12522A, 12528A
12708A, 12720A, 12722A, and 12728A

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Thomas A. Kramer (Full Name) — (Signature) — Director of Quality Assurance (Position)

San Ramon, California (Place)

July 28, 2000 (Date)

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About This Manua

This manual describes the local (front panel) and remote (GPIB) operation of the Giga-tronics Ser 12000A Microwave Synthesizers:

Preface:

In addition to a comprehensive Table of Contents and general information about the manual, th Preface also contains a record of changes made to the manual since its publication, and a descript of Special Configurations. If you have ordered a user-specific manual, please refer to page xv for a description of the special configuration.

Chapters:

1 – Introduction

Contains a brief introduction to the instrument and its performance parameters.

2 – Front Panel Operation

User's guide to the instrument's front panel. All control and features are fully described in chapter.

3 – Remote Operation

Describes how to operate the instrument from a remote location over the General Purpose Interface Bus (GPIB). All programming codes are presented in this chapter with various applications to aid you in understanding the operation.

4 – Performance Test and Calibration

Defines the procedures for inspection, calibration and performance testing of the instrume

Appendices:

A - Accessories and Options

Provides the accessories and options are available for the Series 12000A Microwave Synthesizers. Each accessory and option is described under its respective heading in this appendix.

B – Firmware Field Upgrade

Describes the process by which you can upgrade the application firmware for the Series 120 Microwave Synthesizers.

Index:

A subject listing of contents.

Changes that occur after publication of the manual, and Special Configuration data will be inserte loose pages in the manual binder. Please insert and/or replace the indicated pages as detailed in the Technical Publication Change Instructions included with new and replacement pages.

Conventions

The following conventions are used in this product manual. Additional conventions not included here will be defined at the time of usage.

Warning

WARNING

The WARNING statement is encased in gray and centered in the page. This calls attention to a situation, or an operating or maintenance procedure, or practice, which if not strictly corrected or observed, could result in injury or death of personnel. An example is the proximity of high voltage.

Caution

CAUTION

The CAUTION statement is enclosed with single lines and centered in the page. This calls attention to a situation, or an operating or maintenance procedure, or practice, which if not strictly corrected or observed, could result in temporary or permanent damage to the equipment, or loss of effectiveness.

Notes

☛ ***NOTE:*** *A NOTE Highlights or amplifies an essential operating or maintenance procedure, practice, condition or statement.*

Giga-tronics: Serial, Code, Model, Option or Configuration Label

Examine the code, model serial, option or config. label affixed to the rear panel.

Serial Number

Each instrument has a seven-digit serial number, shown on the label on the rear panel.

Code Number

Each instrument has a two-digit number. This number is the Manufacturing Configuration Code.

Model Number

Each instrument has a 5-digit serial number, and one suffix character which designates the series (12XXXA); Model Type (125XXA) Step or (127XXA) Ramp; Frequency Range (12X08A) 0.01 to 8 GHz, (12X20A) 0.01 to 20 GHz, (12X28A) 2 to 8 GHz, (12X22A) 2 to 20 GHz, Suffix character A is the Series version.

Option Number

If the line is blank, there are no options installed. Option(s) are installed when one or more 2 digit numbers are on the line which correspond to the option numbers in Appendix A.

Configuration Number

If the *Config.* line contains a three digit number (e.g., 241), there is a combination of options and/or special modifications installed in the instrument. Information relating to special configurations will be contained in supplemental pages included with this manual.

Record of Manual Changes

This table is provided for your convenience to maintain a permanent record of manual change data. Corrected replacement pages will be issued as Technical Publication Change Instructions, and will be inserted at the front of the binder. Remove the corresponding old pages, insert the new pages, and record the changes here.

Change Instruction Number	Change Instruction Date	Date Entered	Comments

Special Configurations

When the accompanying product has been configured for user-specific application(s), supplemental pages will be inserted at the front of the manual binder. Remove the indicated page(s) and replace it (them) with the furnished Special Configuration supplemental page(s).

1 Introduction

1.1 General Information

1.1.1 Introduction

The 12000A is a microwave synthesizer with step, ramp and list sweep capability; it operates over a wide range of microwave frequencies and power levels, and in a variety of modulation modes. The 12000A can generate output signals over a frequency range of 10 MHz to 20 GHz; the frequency range is dependent on the specific model number (see below). The RF output can be fixed (CW), step, ramp or list sweep with external frequency, amplitude, or pulse modulation.

Installation instructions are in Section 1.2. Performance specifications are in Section 1.3. Operation from the instrument front panel is detailed in Chapter 2. Instructions on how to operate the instrument from a remote host computer over the General Purpose Interface Bus are in Chapter 3.

The following are the 12000A model numbers with their respective frequency range:

Table 1-1: 12000A Model Numbers

CW, Step, and List Sweep	CW, Step, Ramp, and List Sweeps	Frequency Range
Model 12508A	Model 12708A	10 MHz to 8 GHz
Model 12528A	Model 12728A	2 GHz to 8 GHz
Model 12520A	Model 12720A	10 MHz to 20 GHz
Model 12522A	Model 12722A	2 GHz to 20 GHz

1.1.2 Features

- Advanced digital processing architecture, driving a high-speed, ferrite-based YIG oscillator
- Spectrally pure output with a tuning resolution of 0.1 Hz
- Optimum oscillator fast switching speed while maintaining low phase noise
- Field-programmable gate arrays perform logic operations quickly while a digital signal processor functions as a secondary processor for dynamic control and fast frequency settings without burdening the primary processor
- The frequency ramp sweep technique provides an analog-like ramp sweep using a high-speed digital step sweep of the synthesizer between pre-defined start and stop frequencies. Linearity errors are virtually eliminated because the frequency is stepped at a faster rate than the PLL bandwidth, essentially producing a swept phase locked loop

1.1.3 Environmental Standards

The 12000A is environmentally tested for compliance with MIL-PRF-28800F, Class 3.

1.1.4 Items Furnished

Accessories and options are detailed in Appendix B to this manual. In addition to options and/or accessories specifically ordered, the following items are furnished with the instrument:

- Operation Manual, P/N 31231
- Power cord (6-ft.), P/N WMPO-03007

1.1.5 Items Required

An IEEE 488 interface cable is needed for remote control operation. Appropriate RF output cabling made to fit the female type SMA output connector can be ordered as an Accessory Cable Kit, No. A001. No special tools are required to operate the 12000A. Test equipment required for calibration or performance verification is described in Chapter 4.

1.1.6 Cooling

A cooling fan is installed in the instrument. The cooling air intake is located on the rear panel. Care must be taken to avoid obstructing the flow of air into the instrument.

1.1.7 Cleaning

The air intake screen should be cleaned whenever a significant amount of dust has accumulated on it. Whenever the instrument covers are removed, the interior should be blown out with dry air at a low velocity.

1.1.8 Preparation for Reshipment

If it is necessary to return the instrument to the factory, protect the instrument during reshipment by using the best packaging materials available. If possible, use the original shipping container. If the original container is not available, use a strong carton (350 lbs./sq.in. bursting strength) or a wooden box. Wrap the instrument in heavy paper or plastic before placing it in the shipping container. Completely fill the areas on all sides of the instrument with packaging material. Take extra precaution to protect the front and rear panels. Seal the package with strong tape or metal bands. Mark the outside of the package: **"FRAGILE — DELICATE INSTRUMENT"**.

If corresponding with the factory or the local Giga-tronics sales office regarding reshipment, please provide the model and serial number. If the instrument is being returned for repair, be sure to enclose all relevant information regarding the problem that has been found.

☛ ***NOTE:*** *If you are returning an instrument to Giga-tronics for service, first contact Customer Service so that a return authorization number (RMA) can be assigned via e-mail at* ***repairs@gigatronics.com*** *or at* ***800.444.2878*** *(The 800 number is only valid within the US). You may also try our domestic line at* ***925.328.4650*** *or Fax at* ***925.328.4702****.*

1.2 Installation

The instrument is shipped in operational condition and no special installation procedures are required. A warm-up time of 20 minutes is recommended for normal operation (see Chapter 4 for warm-up time prior to calibration and testing). Each Giga-tronics instrument must pass rigorous inspections and tests prior to shipment. Following installation, the performance of the 12000A should be checked immediately to insure that operation has not been impaired during shipment. Performance verification procedures are detailed in Chapter 4.

1.2.1 Rear Panel Interface

This section defines the functions and interface of the rear panel (see Figure 1-1). Some connectors are duplicates of those on the front panel (see Figure 2-2 for an illustration of the front panel). The RF Out connector will be installed on the front panel unless the instrument includes Option 22, which relocates the connector to the rear panel (see Figure 1-1).

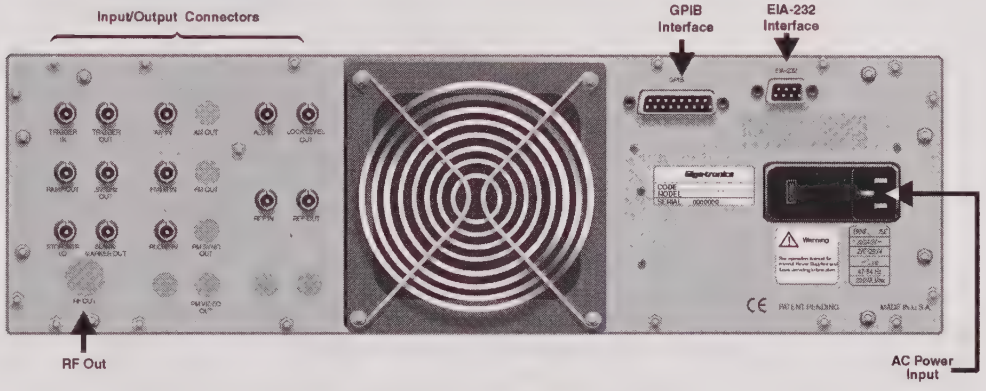

Figure 1-1: 12000A Rear Panel

Line Voltage

The 12000A contains primary and standby power supplies with internal switching. The instrument automatically senses the input line voltage in the range of 90 to 253 Vac, 47 to 64 Hz (400 Hz optional). There are no manual voltage adjustments or selection controls. The 12000A has a 3-wire power cord with a 3-terminal polarized plug for connection to the power source and safety ground.

The power cord cannot be longer than 3 meters (9 feet) to meet safety requirements.

WARNING

The safety ground is connected directly to the chassis. If a 3-to-2 wire adapter is to be used, be sure to connect the ground lead from the adapter to earth ground. Failure to do this could cause the instrument to float above ground, posing a shock hazard.

CAUTION

DO NOT position the equipment so that it is difficult to operate the disconnecting device (to remove the AC line cord).

Line Fuse

The 12000A has a line fuse container on the rear panel.

Fuse Installation

The power line fuse is a 2A, Slo-Blo, 250V, Type T (see Figure 1-2 for location).

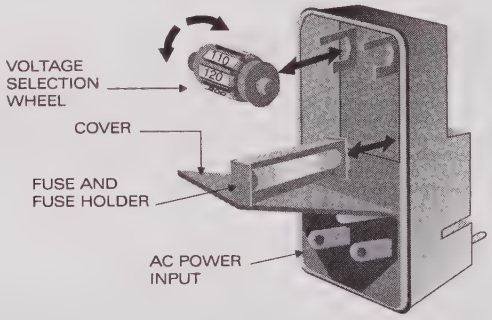

Figure 1-2: Fuse Holder

The fuse holder is contained in the covered housing directly above the AC power connector on the rear panel. To gain access, use a small screwdriver or similar tool to snap open the cover and proceed as follows:

1. **To replace the fuse:**

   Pull out the small drawer on the right side of the housing (marked with an arrow) and remove the old fuse. Replace with a new fuse, insert the drawer and close the housing cover (see Figure 1-2).

Rear Panel I/O Connectors

REF OUT A buffered square wave output at 10 MHz, 2 V_{P-P} minimum into 50 Ω, derived from the internal or external timebase.

REF IN An external timebase input signal, 5 or 10 MHz $\pm 1 \times 10^{-6}$ or better, 0.5 to 5 V_{P-P}, overrides the internal time base. Input impedance is 100 Ω nominal.

STOP SWP I/O A TTL-compatible input/output (low input stops a sweep; low output indicates that a sweep has been stopped).

LOCK/LEVEL OUT A TTL-compatible output (high indicates the output frequency is phase locked and the output power is leveled).

ALC IN An input signal for remote leveling control of output power by positive or negative polarity ZBS detectors, or by applicable power meters (duplicates the front panel ALC IN connector).

PM VIDEO OUT A pulse modulation envelope waveform at TTL level, approximately 4 V_{P-P} into 50 Ω (Option 24 only).

BLANK/MKR OUT A sweep related output: +5 V or -5 V during band changes, filter changes, and sweep retrace; 0 V during sweep; +5 V or -5 V at marker frequencies (signal polarity is software controlled).

RAMP OUT 0 to +10 V ramp output, proportional to progress between sweep limits.

PM SYNC OUT 50 ns wide trigger pulse output at TTL levels (approximately 4 V into 50 Ω), coincident with leading edge of the pulse modulation envelope (Option 24 only).

TRIGGER IN This connector accepts a sweep trigger input ≥50 ns wide at TTL level to initiate a sweep or step.

TRIGGER OUT This connector accepts a sweep trigger outout coincedent with the frequency step ending the event.

AM OUT An amplitude modulation waveform output at ~2 V_{P-P} into 10 kΩ (Option 24 only).

0.5V/GHz OUT An output voltage directly proportional to the RF output frequency.

PULSE IN PM input signal for external pulse modulation (duplicates the front panel PULSE IN connector).

FM OUT A frequency modulation waveform output at ~2 V_{P-P} into 10 kΩ (Option 24 only).

AM IN This connector accepts the input signal from a 600 Ω external amplitude modulation source (duplicates the front panel AM IN connector).

FM/ΦFM IN This connector accepts the input signal from a 50 Ω external frequency or phase modulation source (duplicates the front panel FMΦFM IN connector).

RF Out This is the instrument's RF output signal on a type SMA (f) connector. It replaces the RF Out connector on the front panel when the instrument is configured for Option 22 (see Appendix B for the details of Option 22).

Front Panel I/O Connectors

Refer to Figure 2-17 in Chapter 2 for an illustration of these connectors.

ALC IN An input signal for remote leveling control of output power by positive or negative polarity ZBS detectors, or by applicable power meters (duplicates the rear panel ALC IN connector).

AM IN This connector accepts the input signal from a 600 Ω external amplitude modulation source (duplicates the rear panel AM IN connector).

FM/ΦFM IN This connector accepts the input signal from a 50 Ω external frequency or phase modulation source (duplicates the rear panel FMΦFM IN connector).

PULSE IN This connector accepts the input signal from a 50 Ω external pulse modulation source (duplicates the rear panel PULSE IN connector).

RF Out This is the instrument's RF output on a type SMA (f) connector located on the front panel. (Option 22 for rear panel location).

Interface Connectors

GPIB IEEE 488.2 interface connection (24-pin) between the 12000A and host computer equipment for remote operation over the General Purpose Interface Bus (GPIB). The connector pin assignments are listed in Table 1-2.

Table 1-2: IEEE 488.2 Hardware Configurations

Pin	Signal	Pin	Signal	Pin	Signal
1	D101	9	IFC	17	REN
2	D102	10	SRQ	18	GND (6)
3	D103	11	ATN	19	GND (7)
4	D104	12	Shield	20	GND (8)
5	EO1	13	D105	21	GND (9)
6	DAV	14	D106	22	GND (10)
7	NRFD	15	D107	23	GND (11)
8	NDAC	16	D108	24	GND Logic

EIA-232 This 9-pin connector interfaces communications equipment using RS-232 format. See Table 1-3 for the connector pin assignments.

Table 1-3: EIA-232 Pin Assignments

Pin	Function
1	Protective Ground
2	Transmitted Data
3	Received Data
4	Request To Send
5	Clear To Send
6	Data Set Ready
7	Signal Ground
8	Carrier Detect
9	Reserved for modem testing

1.3 Performance Specifications

CW Operation

Range: 0.01 to 8 GHz; 2 to 8 GHz; 0.01 to 20 GHz; and 2 to 20 GHz.

Resolution: 0.1 Hz (standard); 1 kHz (with Option 36).

Accuracy and Stability: Identical to time base oscillator.

Time Base (Internal): 10 MHz.

Aging Rate: $<1 \times 10^{-9}$/day after 72 hours continuous operation ($<5 \times 10^{-10}$/day with Option 28).

Temperature Stability: $<\pm 2 \times 10^{-10}$/ °C (0 to +55 °C).

Time Base (External): 5 or 10 MHz, $\pm 1 \times 10^{-6}$ or better; 0.5 to 5 V_{P-P} into 500 Ω, nominal.

Switching Time: <500 µs to within 1 kHz of set frequency with Residual FM (0.3 - 3 kHz) of 3 kHz RMS for 1 ms.

RF Output

Maximum Leveled Output (0 to 35 °C):

Frequency Range	Standard	Option 26
.01 to 2.0 GHz	+15 dBm	+14 dBm
>2.0 to <8.0 GHz	+15 dBm	+15 dBm
8.0 to 15.0 GHz	+15 dBm	+13 dBm
>15.0 to 20.0 GHz	+15 dBm	+12 dBm

Incremental Level Range: -20 to +20 dBm.

Resolution: 0.01 dB, entry and display.

Minimum Calibrated Output Level: -10 dBm (-120 dBm with Option 26).

RF Off: Attenuates the output to ≤ –140 dBm at the output connector.

Output Flatness: (Internally leveled, CW freq. sweep mode or ramp mode) 15 to 35 °C <±0.5 dB (0 dBm to maximum specified power). Add ±0.1 dB/10 dB with Option 26.

Output Accuracy: ±0.7 dB.

Maximum Slope of Level Variation: <0.5 dB/MHz.

Output Switching Time: <500 µs; 20 ms with attenuator change (Option 26).

Output Impedance: 50 Ω, nominal.

Output SWR: <2.0:1.

External Leveling: Output power may be externally leveled by positive or negative ZBS detectors or power meters.

Level Drift: < 0.05 dB/hour, maximum: 0.1 dB/24 hours.

The table below lists the specifications that are changed when Option 20 is active. Specifications apply from 0° to 35° C.

Flatness	± 2.5 dB
Harmonics	< -5 dBc, 0.1 to 2 GHz
	< -20 dBc, 2 to 20 GHz
Pulse on/off ratio	≥ 60 dB
AM	Functional, but not specified above 0 dBm

NOTE: *Due to the losses in the relay and the extra cables, the maximum power of the instrument with Option 20 disabled is 2 dB less than the standard instrument specification.*

Spectral Purity

Harmonics:

Frequency (GHz)	Harmonic (dBc)	Power (dBm)
.01 to 0.1	-30	+6
>0.1 to 2.0	-50	+6
>2.0 to 20	-60	+6

Subharmonics: -65 dBc.

Nonharmonics: <-60 dBc (0.01 to 16 GHz); <-55 dBc (>16 to 20 GHz).

Single-Sideband Phase Noise: dBc/Hz, CW mode, all power levels:

Freq (GHz)	Offset from Carrier				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
0.25	-101	-101	-109	-122	-125
0.5	-95	-95	-103	-122	-124
2.0	-87	-92	-94	-120	-125
4.0	-81	-86	-88	-110	-130
6.0	-81	-84	-85	-110	-130
8.0	-75	-80	-82	-105	-130
10.0	-75	-80	-82	-105	-125
18.0	-69	-75	-75	-100	-120
20.0	-69	-75	-75	-100	-120

Residual FM: Hz, RMS, CW mode:

Frequency Range (GHz)	Post-detection Bandwidth	
	300 Hz to 3 kHz	50 Hz to 15 kHz
<2.0	Decreases by 1/2 per oct	Decreases by 1/2 per oct
2 to 3.99	<6	<35
4 to 7.99	<12	<70
8 to 15.99	<24	<140
16 to 20	<32	<200

AM Noise: ≤130 dB/Hz (0.01 to 2.0 GHz); ≤145 dBm/Hz (>2.0 GHz); Typical 5 MHz offset.

Ramp Frequency Sweep

Continuous sweep:	Generated within the instrument, can be operated simultaneously with Step power sweep.
Range:	From FA (minimum frequency of instrument) to FB (maximum frequency of instrument).
Sweep Time:	1 ms to 200 s (any sweep mode).
Resolution:	10 µs.
Minimum Sweep Time:	Determined by the sweep width and the maximum sweep speed.
Minimum Sweep Width:	100 Hz (1 MHz with Option 36).
Minimum Sweep Speed:	100 kHz/sec.
Maximum Sweep Speed:	1 Octave/8 ms (general spec) determined by the frequency band.
Band Crossing Dead Time:	<400 µs.
Sweep Width Resolution:	0.1 Hz (1 kHz with Option 36).
Start, Stop, Halted Frequency Accuracy:	Phase-locked to time base.
Sweep Linearity:	<0.5% of sweep width (relative to the linear 0 to +10V Ramp Out voltage, sweep time ≥10 ms, any sweep mode).
Sweep Modulation Formats:	AM or Pulse Modulation.
Ramp Sweep Mode:	
Start/Stop:	FA ≤ [F1 ≠ F2] < FB Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2).
Start/Δ:	FA ≤ [F1 ± ΔF] ≤ FB Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF).
CTR/Δ:	FA ≤ [CF ± (ΔF/2)] ≤ FB Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF).
Δ MKR:	FA ≤ [Mx ≠ My] ≤ FB Sweeps up or down from any preset marker (Mx) to any other preset marker (My).
Ramp Sweep Functions:	
Auto:	Continuous cycle of the preset sweep.
Single:	A single cycle of the preset sweep, initiated by manual operation of the front panel pushbutton or reception of the corresponding GPIB command.
EXT:	A single cycle of the preset sweep, initiated by a trigger input from an external source.
Manual:	Stops the sweep when activated by the front panel pushbutton, the assertion of the Stop Sweep I/O BNC, or the reception of the corresponding GPIB command to enable manual tuning of the frequency at any point in the sweep. Permits continuation of the current frequency.
Frequency Markers (Step and Ramp frequency sweep):	Twelve intensity, video, and/or amplitude markers individually selected from either the front panel or reception of the corresponding GPIB command.

Resolution: Sweep width ÷ 4000.

Accuracy: Same as Sweep linearity except the marker may vary ± 25 mV relative to the linear 0 to +10 V Ramp Out.

Amplitude Markers: A -10 to +10 dB change in RF output during Ramp frequency sweep.

Video Markers: TTL-level output or ±5 V.

Intensity Markers: Provides a timed dwell of frequency sweep.

Step Frequency Sweep

Range: FA (minimum frequency of instrument) to FB (maximum frequency of instrument).

Step Size: Any increment within the frequency resolution.

Dwell Time: May be set in 1 ms increments from approximately 1 ms to 200 sec.

Setup Time: 200 μs/step, typical.

Accuracy And Stability: Same as in CW when locked at each step during dwell time.

Step Sweep Modes:

Start/Stop: FA ≤ [F1 ≠ F2] ≤ FB
Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2).

Start/Δ: FA ≤ [F1 ± ΔF] ≤ FB
Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF).

CTR/Δ: FA ≤ [CF ± (ΔF/2)] ≤ FB
Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF).

Start/Steps: FA ≤ [F1 ± (step size × no. of steps)] ≤ FB
Sweeps up or down from a preset start frequency (F1) through a preset number of frequency steps.

Step Sweep Functions:

Auto: Continuous cycle of the preset sweep.

Single: A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by the front panel pushbutton or reception of the corresponding GPIB command.

EXT: A single cycle of the preset sweep initiated by each trigger from an external source.

EXT Step: A single step of a preset step sweep, initiated by each trigger input from an external source.

Manual: Stops the sweep when activated by the front panel pushbutton, assertion of the Stop Sweep I/O BNC, or reception of the corresponding GPIB command to enable manual tuning of the frequency to any point in the sweep. Permits continuation from the current frequency.

Ramp Power Sweep

Continuous sweep, generated within the instrument. Can be operated simultaneously with Ramp or Step frequency sweep.

Range: -10 dBm to maximum power (-120 dBm to maximum power with Option 26).

Sweep Time (any sweep mode): 2 ms to 200 ms in five ranges. Minimum sweep time is determined by the sweep width and the maximum sweep speed.

Minimum Sweep Width: 0.01 dB.

Maximum Sweep Speed: 1 dB/ms.

Range	Resolution
2.0 to 20.0 ms	10.0 µs
20.0 ms to 200.0 ms	100.0 µs
200.0 ms to 2.0 sec	1.0 ms
2.0 sec to 20.0 sec	10.0 ms
20.0 sec to 200.0 sec	100.0 ms

Sweep Level Resolution (any sweep mode): 0.01 dB.

Start Level Accuracy (any sweep mode): ±0.5 dB (-10 to +11 dBm).

Sweep Level Linearity (any sweep mode): ±5% of sweep width.

Ramp Power Sweep Modes:

Start/Stop: $LA \leq [L1 \neq L2] \leq LB$
Sweeps up or down from a preset start level (L1) to a preset stop level (L2).

Start/Δ: $LA \leq [L1 \pm \Delta L] \leq LB$
Sweeps up or down from a preset start level (L1) through a preset sweep width (ΔL).

Ctr/Δ: $LA \leq [CL \pm (\Delta L/2)] \leq LB$
Sweeps up or down through a preset sweep width (ΔL) centered symmetrically about a preset center level (CL).

Ramp Power Sweep Functions:

Auto: Continuous cycle of preset sweep.

Single: A single cycle of the preset sweep, initiated by manual operation of the front panel pushbutton or reception of the corresponding GPIB command.

EXT: A single cycle of the preset sweep, initiated by a trigger input from an external source.

Manual: Stops the sweep when activated by the front panel pushbutton, the assertion of the Stop Sweep I/O BNC, or the reception of the corresponding GPIB command to enable manual setting of the level to any point in the sweep. Permits continuation of the current level.

Step Power Sweep

Range:	LA (minimum level of instrument) to LB (maximum level of instrument).
Step Size:	Any multiple of 0.01 dB up to maximum sweep range.
Dwell Time:	May be set in 1 ms increments from approximately 1 ms to 200 sec.
Setup Time/step:	100 µs, typical.
Accuracy & Stability:	Same as in CW when leveled at each step during dwell time.
Step Power Sweep Modes:	
Start/Stop:	LA ≤ [L1 ≠ L2] ≤ LB Sweeps up or down from a preset start level (L1) to a preset stop level (L2).
Start/Δ:	LA ≤ [L1 ± ΔL] ≤ LB Sweeps up or down from a preset start level (L1) through a preset sweep width (ΔL).
Ctr/Δ:	LA ≤ [CL ± (ΔL/2)] ≤ LB Sweeps up or down through a preset sweep width (ΔL) centered symmetrically about a preset center level (CL).
Start/Steps:	LA ≤ [L1 ± (step size × number of steps)] ≤ LB Sweeps up or down from a preset start level (L1) through a preset number of level steps.
Step Power Sweep Functions:	
Auto:	Continuous cycle of the preset sweep.
Single:	A single cycle of the preset sweep or (with stop activated) a single preset step, initiated the front panel pushbutton or receipt of the corresponding GPIB command.
Ext:	A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by a trigger input from an external source.
Manual:	Stops the sweep when activated by the front panel pushbutton, the assertion of the Stop Sweep I/O BNC, or reception of the corresponding GPIB command to enable manual adjustment of the level at any point in the sweep. Permits continuation from the current level.

Modulation Parameters and Operational Modes

Option 24 provides two function generators for internal generation of amplitude and frequency modulation envelope waveforms. A pulse generator is also provided (Modes: free-run, triggered, gated, delayed, single, double, triple and quadruple).

Pulse/Square Wave Modulation (PM)

PM Envelope Parameters:

Specifications apply with Scan/AM and FM off. PM may be operated with FM and/or Scan.

On/Off Ratio: >80 dB at +10 dBm.

Rise/Fall Times:

Rise Time	Frequency Range
< 10 ns	> 500 MHz
< 50 ns	> 64 to 500 MHz
< 350 ns	25 to 64 MHz
< 500 ns	< 25 MHz

Overshoot, Undershoot and Ringing: <10%, >500 MHz, maximum.

Settling Time: <75 ns to within 1 dB (for pulses > 75 ns).

Leveled Pulsed Output Power: Referenced to CW output power at 15 to 35 °C: ±0.5 dB, ≥100 ns pulse width, ±1 dB pulse width, between 100 ns and 75 ns.

Minimum Width	Frequency Range
20 ns	> 500 MHz
100 ns	64 to 500 MHz
1 µs	< 25 to 64 MHz

Internally Generated PM Envelope (Option 24):

Repetition Rate:

Range	Resolution
1 Hz to 1000 Hz	1 Hz
1 kHz to 10 kHz	10 Hz
10 kHz to 100 kHz	100 Hz
100 kHz to 1MHz	1 kHz
1 MHz to 3 MHz	10 kHz

Pulse Start Delay: Referenced to sync output.

Range: 50 ns to 1.67 sec.

Resolution: 10 ns.

Accuracy: ±1% of setting, or ±20 ns, whichever is greater.

Jitter: ±0.01% of setting or ±100 ps, whichever is greater.

Pulse Width:

Range: 100 ns to 1.67 sec.

Resolution: 10 ns.

Accuracy: ±1% of setting or 20 ns, whichever is greater.

Jitter: ±0.01% of setting or 100 ps, whichever is greater.

Pulse Modes: Trigged singlet, doublet, triplet, quadlet and free run.

Intervals:	
Range:	100 ns to 1.67 sec.
Resolution:	10 ns.
Accuracy:	±1% of setting or 20 ns, whichever is greater.
Jitter:	±0.01% of setting or 100 ps, whichever is greater.
Output:	Sync TTL levels into a 50 Ω load.
	50 ns pulse coincident with start delay.
	Video TTL levels into a 50 Ω load.

Externally Triggered PM Envelope:

	One envelope produced by each trigger supplied.
Repetition Rate:	5 Hz to 5 MHz.
Pulse Delay:	Set by internal delay control.
Pulse Width:	Set by internal width control.
Input Trigger Required:	Positive or negative-going TTL level trigger pulse, >20 ns wide.

Externally Generated PM Envelope:

	One envelope produced by each pulse supplied.
Repetition Rate:	5 Hz to 5 MHz, leveled output; dc to 10 MHz, unleveled output.
Pulse Delay:	50 ns, typical (output envelope leading edge referenced to input pulse leading edge).
Input Pulse Required:	Positive or negative-going TTL level trigger pulse, >50 ns wide (leveled output); ≥20 ns wide (unleveled output). Input impedance is 50 Ω.

Amplitude Modulation (AM)

Specifications apply with FM off; AM may be operated simultaneously with FM

AM Envelope Parameters:

Modulation Depth:	0 to 90%, typical, at 0 dBm output power.
Modulation Resolution:	1%.
Modulation Bandwidth:	DC to 150 kHz, ±3 dB at 0 dBm output.
Modulation Accuracy:	±10% of depth setting.

Externally Supplied AM Envelope:

Waveform:	Any waveform compatible with bandwidth considerations.
Input Sensitivity:	(AM depth control set to 100%) 1 V_{P-P} for 50% depth ±10% depth, at 1 kHz modulation rate.
Input Impedance:	600 Ω, nominal.

Internally Generated AM Envelope:

(Option 24 only).

Waveform	Sine, square, sawtooth, or triangle wave.
Rate:	0.01 Hz to 1 MHz.
Resolution:	2.5 mHz.
Accuracy:	Same as timebase.

Scan Modulation

(Specifications apply with FM and PM off; Scan may be operated simultaneously with FM and/or PM).

Envelope Parameters:

Frequency of Operation:	0.01 to 20 GHz.
Scan Mode:	
Range:	0 to 60 dB at +10 dBm output power.
Resolution:	0.1 dB.
Sensitivity:	-10 dB/V in 1 dB increments.
Step Response:	< 1 µs for 50 dB change > 1 GHz (<10 µs below 1 GHz).
Frequency Response:	DC to 150 kHz, sine wave, 3 dB.
Linearity:	±0.6 dB, 0 to -20 dB; ±1 dB @ 20 to 60 dB.
Input Impedance:	600 Ω, nominal.
Accuracy:	.25 dB +/- 5% at depth in dB (for .01 to 2 GHz specification applies only up to 30 dB).

Frequency Modulation (FM)

Specifications apply with Scan/AM and PM off; FM can be operated simultaneously with Scan/Linear AM and/or PM (PM and linear AM are not allowed simultaneously).

FM Envelope Parameters:

Wide Mode:

Max Deviation: See following Table.

Minimum Deviation: 10 kHz at 4 to 8 GHz (other ranges proportional).

Modulation Resolution: 1 kHz (deviation <1 MHz); 10 kHz (deviation >1 MHz) at 4 to 8 GHz (other ranges proportional).

Flatness: ±2 dB for rates from 100 Hz to 1 MHz; ±3 dB to 8 MHz.

Residual FM: See following table.

Narrow Mode:

Max Deviation: See following Table.

Modulation Resolution: 10 Hz (deviation <10 kHz); 1 kHz (deviation >10 kHz) at 4 to 8 GHz (other ranges proportional).

Flatness: ±2 dB for rates from DC to 1 MHz.

Residual FM: Same as CW.

Both Modes:

Modulation Accuracy: +5%, at maximum deviation and 1 kHz modulation rate.

Distortion: <5% (±1 MHz deviation); 4 to 8 GHz range.

Incidental AM: ±0.2%/MHz of deviation.

Phase Modulaton Parameters:

Modulation Frequency: 10 kHz to 100 kHz (Narrow).

100 Hz to 100 kHz (Wide).

Max Modulation Index: See following table.

Frequency (GHz)	Max Wide Deviation (Peak)	Max Narrow Deviation (Peak)	Wide Mode Residual FM	Max Wide Mode Index Radians	Max Narrow Mode Index Radians
.010 to .016	40 kHz	2 kHz	200 Hz	0.4	.02
.016 to .032	80 kHz	4 kHz	200 Hz	0.8	.04
.032 to .064	160 kHz	8 kHz	200 Hz	1.6	.08
.064 to .125	320 kHz	16 kHz	200 Hz	3.2	.16
.125 to .25	640 kHz	32 kHz	200 Hz	6.4	.32
.25 to .5	1.25 MHz	64 kHz	200 Hz	12.5	.64
.5 to 1	2.5 MHz	125 kHz	375 Hz	25	1.25
1 to 2	5 MHz	250 kHz	<750 Hz	50	2.5
2 to 4	10 MHz	.5 MHz	<1.5 kHz	100	5
4 to 8	20 MHz	1 MHz	<3 kHz	200	10
8 to 16	40 MHz	2 MHz	<6 kHz	400	20
16 to 20	80 MHz	4 MHz	<12 kHz	800	40

Internally Generated FM Envelope:

(Option 24 only).

Waveform:	Sine, square, sawtooth, or triangle wave.
Rate:	0.01 Hz to 1 MHz.
Resolution:	2.5 mHz.
Accuracy:	Same as timebase.
THD:	1% typical.

Externally Supplied FM Envelope:

Waveform:	Any waveform compatible with bandwidth considerations.
Rate:	DC to 8 MHz Narrow Mode, 100 Hz to 8 MHz Wide Mode.
Input Sensitivity:	Settable; 1 Vp input for maximum peak deviation (FM deviation control set to maximum).
Input Impedance:	50 Ω, nominal.

1.4 General Specifications

Remote Interface:	IEEE STD 488.2 for all parameters except AC power on/off. RS-232 Serial Interface DB9 connector.
Operating Temperature:	0 to 55 °C.
Environmental:	Complies with MIL-PRF-28800F, Class 3.
Approvals:	CE marked.
Power:	90 to 253 Vac, auto-sensing, 47 to 64 Hz (400 Hz optional), 200 Watts, nominal.
Line Fuse Rating:	2 A, Slo-Blo, 250V, Type T.
Dimensions:	13.3 cm high x 42.5 cm wide x 53.3 cm deep. (5.25 in H x 16.75 in W x 21 in D)

2

Front Panel Operation

2.1 Introduction

This chapter describes how to operate the 12000A Microwave Synthesizer from its front panel. Refer to Chapter 3 for instructions on how to operate the instrument from a remote host computer over the General Purpose Interface Bus (GPIB) or an RS-232 serial connection. Refer to Chapter 1 for instructions on how to install and interface the instrument before operating it for the first time.

This chapter contains the following major sections:

- Front Panel Description
- Applications Operation

2.2 Front Panel Description

The 12000A front panel contains the controls and display for complete local operation of the instrument. Front panel controls are grouped according to the functions they perform. Descriptions of the controls are referenced to the blocked numbers illustrated in Figure 2-1 on page 2-2.

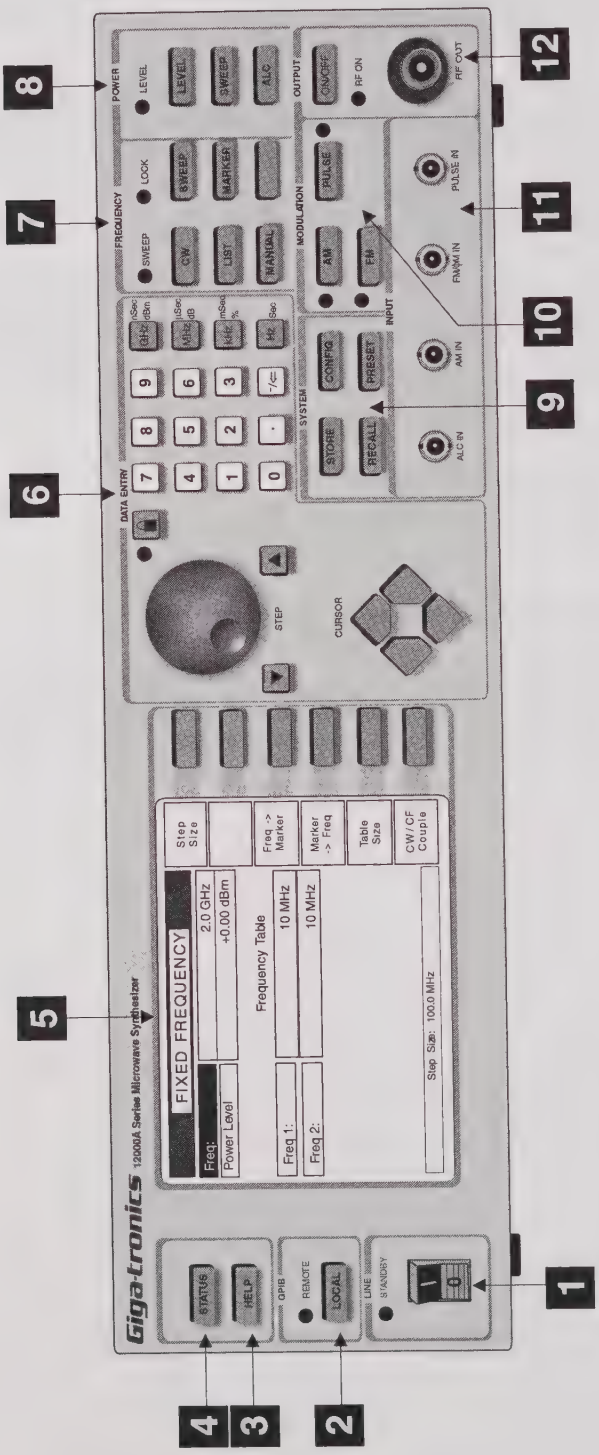

Figure 2-1: Front Panel Layout

1 Power On/Off

When this power switch is turned ON, the adjacent LED will be green. When the power switch is OFF but main power is connected on the rear panel, the LED will be yellow to indicate a standby condition. When the LED is OFF, the main power is disconnected (line cord) or otherwise not supplying ac power.

2 Help

Press **[HELP]** at any time to display the help screen for the selected option or the process being performed when the Help switch is pressed. Press the **[HELP]** switch again or press [*Exit Help*] from the menu to exit the Help screen.

3 Local

Press **[LOCAL]** to transfer operation of the instrument to Local. When in the Remote mode, all front panel controls except the Local switch will be disabled to prevent unauthorized or accidental changes being made at the instrument. The LED indicator adjacent to the Local switch will be ON when the Remote mode is selected; it will be OFF in the Local mode.

4 Status

Press **[STATUS]** to display the current operating mode, frequency, and level. Press the switch again to return to the previous menu, or press any function key to go directly to that function.

5 Display

The display is a 3" x 4" liquid crystal display (LCD) with 320 x 240 line resolution, 0.30 mm dot pitch, and a cold-cathode fluorescent lamp (CCFL) backlight for optimum viewing. The contrast of the display is software controlled (see "System Field" on page 2-5 and reference item 9. Select contrast from the cursor keys, then select knob to adjust to desired contrast).

The Display field includes six interactive softkeys to select the respective options displayed on the right side of the screen (see Figure 2-1). The options will change according to the menu being displayed.

The screen displays real-time configuration and operating data. Front panel configuration parameters are automatically saved in non-volatile memory when entered.

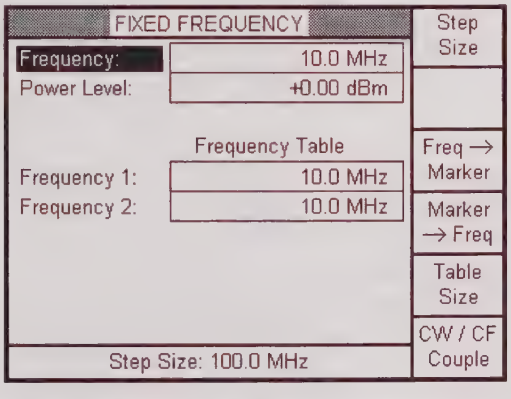

Figure 2-2: Display Screen with Interactive Softkeys

6 Data Entry Field

The DATA ENTRY field contains the 12-button keypad, Units keys, Knob Lock key, cursor keys, and the resolution Step Up/Down keys and adjusting knob. Figure 2-3 illustrates the Data Entry field. Each control within the field is explained in the following paragraphs.

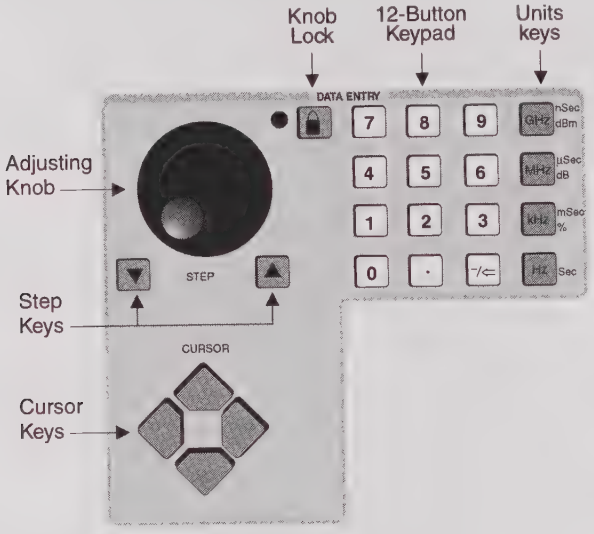

Figure 2-3: The Data Entry Field

Data Entry Keypad — Use this 12-button numeric keypad to enter parameter values and other data that require specific values. The –/⇐ key (located below the numeric 3 key) has a dual function. If it is pressed before a numeric key, a minus sign will precede the first digit. If it is pressed after one or more numeric keys, it functions as a backspace to delete the previous entry.

Units Keys — Press the appropriate Units key to select the units of the parameter in the display and terminate the numeric entry. Any Units key can be used to terminate numeric entries without units.

Knob Lock Key — Press this key to lock (disable) the adjusting knob to prevent unauthorized or accidental changes. Press the key again to unlock the knob. The adjacent green LED will be ON when the adjusting knob is disabled, and OFF when the knob is enabled.

Adjusting Knob — This knob increments or decrements a parameter value by the selected resolution.

Resolution Step Keys — These keys increment or decrement a parameter value by one each time they are pressed. The keys duplicate the action of the adjusting knob except that they always step the value up or down by one. See Section 2.2 for instructions to set the resolution of the Step keys.

Cursor Keys — These four cursor directional keys, arranged in a diamond pattern, step the display cursor up, down, left and right. The cursor is the highlighted data in the display.

7 Frequency Field

The FREQUENCY field controls the mode and frequency parameters when you are operating the unit in a fixed frequency mode.

CW Press **[CW]** to display the current frequency and to enable frequency changes. Use the numeric keypad to change the frequency, and the adjusting knob and/or step keys to adjust the frequency in selective steps.

Sweep Press **[SWEEP]** to display the Sweep parameters and to select alternate sweep methods. You can change the sweep parameters while this menu is displayed. In this mode the LEVEL and LOCK LEDs are not updated.

List Press **[LIST]** to display a list of preset frequencies for high speed operation. With this screen displayed, you can choose the frequency to be used or edit the list to add or delete other frequencies.

Marker Press **[MARKER]** to display the 12 frequency markers used in frequency sweep operation. Position the cursor over a particular marker to set the frequency for that marker. Enter the marker frequency with the Data Entry keypad, or adjust the frequency with the adjusting knob or step keys. Turn a marker on or off from the menu with the interactive data key (the ON position is indicated with the highlighted box to the left of the marker number)

Manual Press **[MANUAL]** to override an active frequency sweep when you want to use manual sweep control with the same parameters (some of the parameters can be changed while in the manual sweep mode and will transfer to the active sweep when it is resumed). The manual sweep mode is available only while a frequency sweep is in progress. If a ramp sweep is in progress, the sweep mode will change to step sweep and remain there.

8 Power Field

This field controls the parameters for power level and sweep operation.

Level Press **[LEVEL]** to adjust the output signal level.

Sweep Press this switch to toggle between step sweep and ramp sweep functions. Use the menu to control the stop, start, center or dwell variables associated with either step or ramp power sweep operation. Ramp sweep is available in the 127XX Series.

ALC The resulting menu when you press **[ALC]** controls the Automatic Level Control (ALC) functions. In addition to selecting the mode and sensor for leveling, the step attenuator, if fitted, can be set to a fixed value.

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System Field

The **SYSTEM** field provides the means to configure the operating parameters and to set the IEEE 488 address. It also provides Store and Recall of up to 10 instrument setup configurations, and a list of configured (preset) items.

Store Press **[STORE]** to store the current instrument setup. You will be prompted to enter an address of 0 through 9, with current assignments and free addresses displayed. See Figure 2-4 below, the next available free step up (for storage) is number 2. Press the number 2 data entry key and the current setup is stored in address 2.

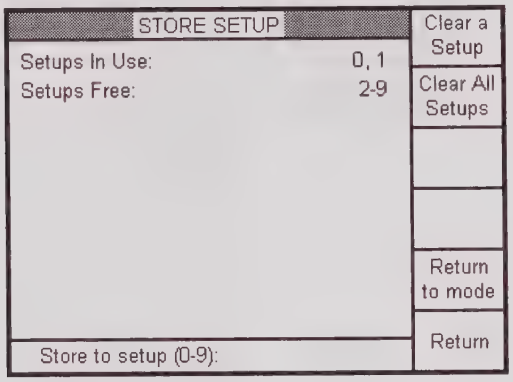

Figure 2-4: Store Setup Selection

Recall Press **[RECALL]** to recall a stored instrument setup. The address of each stored configuration will be displayed. See Figure 2-5 below, stored setups are in addresses 0 and 1.

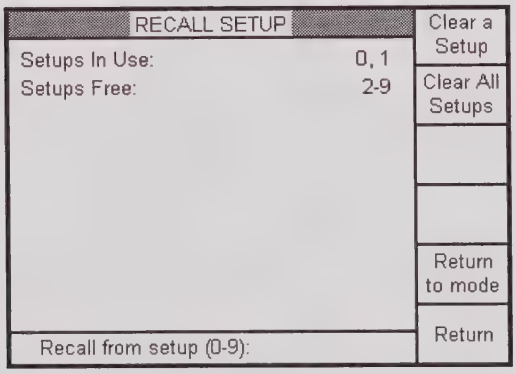

Figure 2-5: Recall Setup Selection

Config Press **[CONFIG]** to display the instrument configuration. You can change the configuration data to generate a new setup, and then store that data to any available memory address for recall when needed.

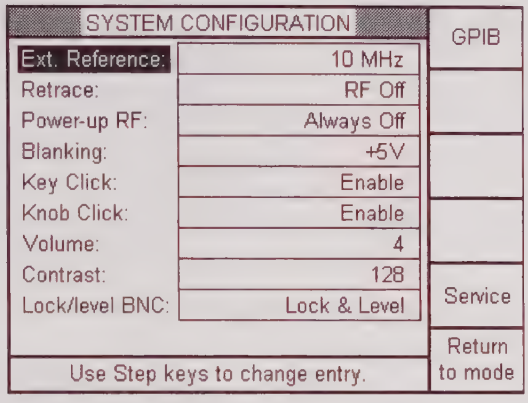

Figure 2-6: System Configuration Selection

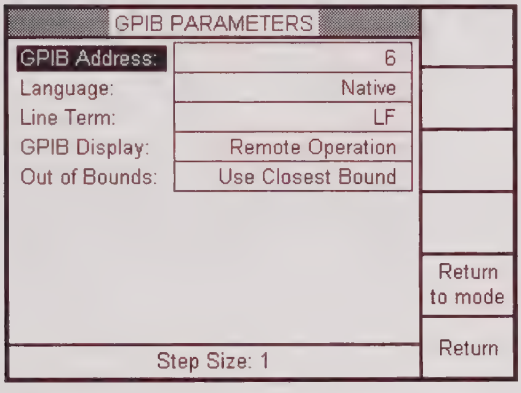

Figure 2-7: System Configuration Selection - GPIB Parameters

Preset Press **[PRESET]** to display the preset menu. Pressing Preset State softkey, presets the instrument to the factory settings. Pressing Initialize NVRAM, sets NVRAM to default values (clears lists, level corrections and setups) and presets the instrument to the factory settings.

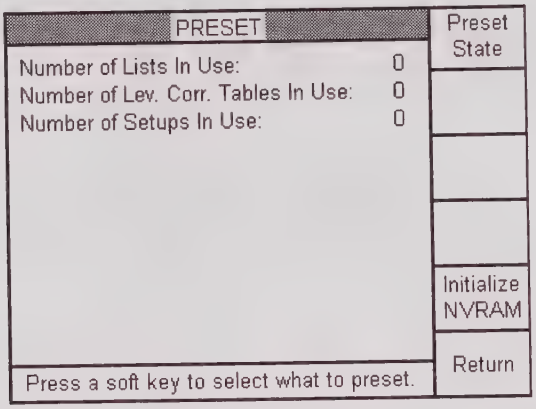
PRESET
Number of Lists In Use: 0
Number of Lev. Corr. Tables In Use: 0
Number of Setups In Use: 0
Press a soft key to select what to preset.
Preset State
Initialize NVRAM
Return

Figure 2-8: System Configuration Selection - Preset

Table 2-1: Factory Default Settings

Parameter	Default Condition	Parameter	Default Condition
CW Frequency	Minimum	FM Rate (Opt. 24)	1 kHz
RF @ Power up	Off	FM Mode	Ext
RF Level	0 dBm	FM Deviation	5 MHz
Amplitude Modulation	Off	Pulse Modulation	Off
AM Rate (Opt. 24)	1 kHz	PM Rate (Opt. 24)	100 kHz
AM Mode	Ext	PM Mode	Ext
AM Depth	50%	PM Width (Opt. 24)	5 us
Frequency Modulation	Off	PM Delay (Opt. 24)	0 ns

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Modulation Field

This field selects the type of modulation to be used. AM, FM, ΦM and PM are available.

AM Press **[AM]** to select amplitude modulation. AM can be linear, expressed in percent, or scan, expressed in dB with the output power being proportional to the input voltage. AM can be internal or from an external source (internal AM is available only when Option 24 is installed).

FM Press **[FM]** to select frequency modulation. FM can have a narrow bandwidth of dc to 1 MHz and a maximum deviation of 1 MHz (in the 4 to 8 GHz range), or FM can have a bandwidth of 100 Hz to 8 MHz and a maximum deviation of 20 MHz (in the 4 to 8 GHz range). FM can be internal or from an external source (internal FM is available only when Option 24 is installed).

ΦM First press **[FM]** then use the mode parameter to select phase modulation.

PM Press **[PM]** to select pulse modulation. PM can be internal or from an external source (internal PM is available only when Option 24 is installed).

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Input Field

The Input field contains four BNC connectors. External modulation sources can be applied to the AM, FM and PM connectors (ΦM uses the FM connector). The ALC input allows use of either a detector or a power meter for remote leveling. All four input connectors are duplicated on the rear panel.

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RF Field

The RF field provides an RF connector and a switch to turn the output on and off. The adjacent LED will be ON when the RF output is turned on. The front panel RF connector will be relocated to the rear panel when Option 22 is installed.

2.3 Front Panel Applications

The remainder of this chapter presents applications examples to illustrate how to operate the 12000A by using the controls on the front panel. Only the features shown in the various menus are available (i.e., there are no other commands or command sets that can be used from the front panel). Refer to Chapter 3 in this manual if you intend to operate the 12000A over a remote interface through the General Purpose Interface Bus (GPIB) or the RS-232 serial interface.

The 12000A features a comprehensive HELP system linked to the current display. Press the **[HELP]** key to display general information about the function — this screen also provides softkeys through which you can select more detailed help topics.

Data Entry for the various menus depends on the type of entry. Parameters with numeric values can be entered and changed by the following methods:

Direct Entry

With the cursor positioned at the far left (e.g., on FREQ in the Fixed Frequency menu as shown in Figure 2-9), enter the numeric value with the keypad. The entry will display in the bottom part of the menu, and will be transferred to the Frequency line when the entry is terminated by pressing the appropriate Units key (any Units key terminates an entry that does not require units).

To enter a negative number, press the [BK/-] keypad button before entering the first digit. After the first digit has been entered, this key functions as a backspace to delete the previous digit.

Increment/Decrement

With the cursor positioned at the far left of the menu, use the knob or step button to continuously vary the numeric value of the digits on the same line with the cursor. The resolution of the steps can be changed by pressing the [*Step Size*] softkey.

Individual Digit Changes

With the cursor positioned at the far left, use the horizontal (left/right) cursor keys to highlight the digit to be changed, then use the knob or step buttons to change the value as desired. Move the cursor to the second digit to be changed and repeat the process until all digits are changed as desired. Parameters with selective values are changed by scrolling through the selections using the knob or step buttons.

Figure 2-9 is an illustration of the 12000A Fixed Frequency menu with the interactive softkeys. Press the softkey to perform the function shown in the adjacent block in the menu. The highlighted area in the display is the cursor, controlled by the cursor keys.

2.3.1 Set a CW Frequency

Press **[CW]** to generate a fixed frequency at a fixed amplitude. The menu illustrated in Figure 2-9 will display, showing the current or last-used frequency. In addition to changing frequencies in this menu,

you can also enter and store up to six frequencies and their associated power output for quick selection. This mode terminates all in-use modulation formats.

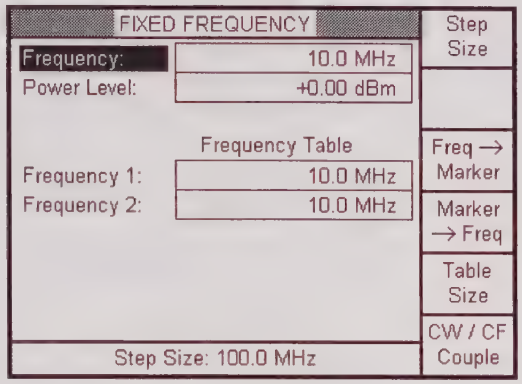

Figure 2-9: Fixed Frequency Menu with Softkeys

With the cursor at the far left as in Figure 2-9, use the keypad to enter the frequency that you want to use. The value you enter will display at the bottom of the screen. When all digits are entered, press the appropriate [UNITS] key to transfer the value to the Frequency line.

In place of using the keypad, you can change one or more of the frequency digits by moving the cursor with the horizontal directional keys to the first digit to be changed and then making the change with the knob or Step keys. Move the cursor to any additional digits to be changed and repeat the process.

If you want to change the incremental resolution of the knob or the step keys, press [*Step Size*] and select either [*Step x10*] to increase the resolution or [*Step /10*] to decrease the resolution. In addition, the step size can be entered with the keypad.

Frequency Table

The Frequency table can contain up to six pre-set frequencies, which you can rapidly select as the CW frequency. Set up the frequencies in the table before you start operation so that you can easily and rapidly select each when needed during the operation.

Select the number of table entries you need by pressing [*Table Size*], then enter the number of entries (1 to 6) with the keypad (0 turns all table entries off). The selected number of table entries will display with the last-set frequency on each line. Set the frequency in each line in the same manner described above for setting the CW frequency.

To select a table frequency as the output CW frequency, move the cursor to the Frequency table entry you desire to use and press [*Table* → Freq]. The value of that entry will immediately appear on the CW Frequency line and the cursor will advance to the next table entry. To set the output power level, see section 2.3.2.

If you plan to use the Power Level table for rapid access, press the **[LEVEL]** button in the Power Field. When you use this approach, the **Frequency** table will change to **Power Level** table. The Power Level table is set and used essentially the same as the Frequency table described in the preceding section with the exception of Frequency markers.

Transfer To/From a Marker

You can either add the CW frequency to the list of Markers or transfer any Marker value to the CW frequency. To transfer the CW frequency to the list of Markers, for first marker, press [**Freq**→Mrkr], for second marker press [*Select Marker*] to select the Marker number to which the frequency will be assigned, then press [*Copy Freq*] to complete the transfer. If you wish to retrieve a marker frequency and use it as the CW frequency, press [**Mrkr**→Freq], press [*Select Marker*] and select the number of the Marker you want to transfer to the CW frequency, then press [*Copy Mrkr*] to complete the transfer.

2.3.2 Set the Power Output

This function automatically sets the power output for the selected frequencies through the use of the internal closed-loop leveling system.

Press **[LEVEL]** to display the Power Output menu illustrated in Figure 2-10. This menu contains the current power output setting and a table of up to six power levels that are stored for quick recall. In addition to setting power output levels in this menu, you can also control the CW frequency.

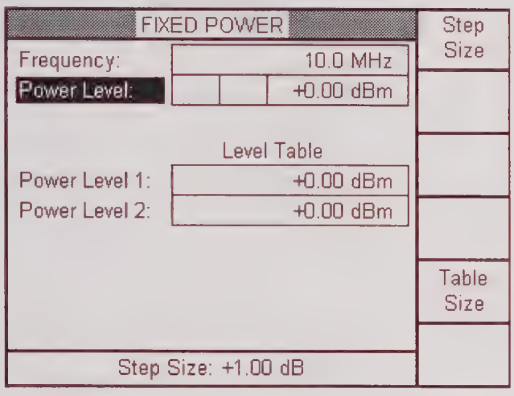

Figure 2-10: Output Power Level Menu

With the cursor at the far left as in Figure 2-10, use the keypad to enter the power output that you want to use. The power value you enter will display at the bottom of the screen. When all digits are entered, press any **[UNITS]** key to transfer the value to the upper Power Output line, measured in dBm.

In place of using the keypad, you can change one or more of the power output digits by moving the cursor with the horizontal directional keys to the first digit to be changed and then making the change with the knob or Step keys. Move the cursor to any additional digits to be changed and repeat the process.

If you want to change the incremental resolution of the knob or the step keys, press [*Step Size*] and select either [*Step x10*] to increase the resolution or [*Step /10*] to decrease the resolution. In addition, the step size can be entered with the keypad.

The table of power settings can contain up to six pre-set levels, which you can rapidly select for use with any CW frequency. Set up the power levels in the table before you start operation so that you can easily and rapidly select each when needed during the operation.

Select the number of table entries you need by pressing [*Table Size*], then enter the number of entries with the keypad (1 to 6, 0 turns all table entries off). The selected number of table entries will display with the last-set power level on each line. Set the frequency in each line in the same manner described above for setting the initial power output.

Refer to Section 2.3.1 to set the Power Output level directly from the CW Frequency menu instead of pressing the **[LEVEL]** key as described in this section.

2.3.3 Configure a Step Frequency Sweep

Use this feature to set up a step frequency sweep. Figure 2-11 illustrates the Step Frequency Sweep menu. A Step Frequency Sweep will start and stop at the frequency values which you designate in the configuration, along with the Repeat mode. You will also need to configure the dwell time at each step, the output power level and type of trigger to be used.

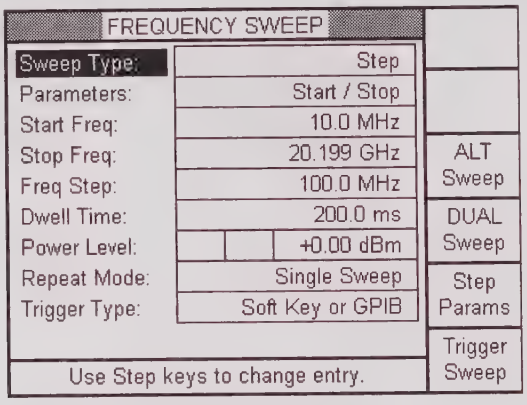

Figure 2-11: Step Frequency Sweep Menu

Move the cursor to highlight the specific parameter to be configured, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up an alternate Step Frequency sweep with individual parameters as defined in this section.
- Set up the Step parameters

Press [*Alt Sweep*] to configure a second Step or Ramp sweep that can be run alternately without having to reconfigure each time.

Press [*Dual Sweep*] to configure a dual Frequency-Power sweep.

Press [*Step Perams*] to see the options for selecting the Step/Dwell or Step/Sweep time or the Points/Dwell or Point/Sweep time.

Press [*Trigger Sweep*] to start a Power sweep after the sweep has been configured.

Step Frequency Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Step Frequency sweep; see Section 2.3.4 for instructions on how to set up a Ramp Frequency sweep. With the cursor on Sweep Type, press either Step key to select Step.

Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop frequencies. Select Center/Span to set up a sweep that allows entering the start frequency and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of a frequency range.

Start or Center Frequency

When using the Start/Stop option, enter the frequency at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Frequency. Enter the center frequency of the sweep.

Stop Frequency or Frequency Span

When using the Start/Stop option, enter the frequency at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Frequency Span. Enter the total frequency that the sweep will span across.

Frequency Step

Enter the value that you want each step of the sweep to take.

Dwell Time

Enter the time you want the sweep to dwell at each step. The dwell time does not include the transition time to arrive at the dwell point.

Power Level

For convenience, you can set the power output level in this menu in the same manner as described in Sections 2.3.1 and 2.3.2.

Repeat Mode

This option determines how a sweep will run. The choices are Single Step, Single Sweep, or Continuous.

Trigger Type

Select the type of trigger that will be used to initiate the frequency sweep. The options are Immediate, which means that a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger In BNC, which will trigger a sweep when a signal is applied to the Trigger In BNC from an external source.

☛ ***NOTE:*** *The Immediate mode is not valid for single step and single sweep.*

2.3.4 Configure a Ramp Frequency Sweep

Use this feature to set up a Ramp frequency sweep. Figure 2-12 illustrates the Ramp Frequency Sweep menu. A Ramp frequency sweep starts at a designated frequency and runs continuously until it reaches a stop frequency. The Ramp sweep can be run as a single sweep or continuously. There are no step options associated with the Ramp Frequency Sweep.

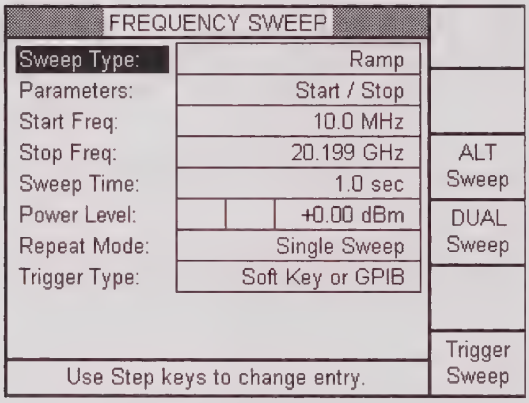

Figure 2-12: Ramp Frequency Sweep Menu

☛ ***NOTE:*** *If the Ramp Frequency Sweep parameters are selected such that the maximum sweep rate allowed for the lowest octave of the full sweep is exceeded, reliable operation of Ramp Frequency Sweep is not guaranteed. Refer to the Ramp Frequency Sweep specifications for details on the maximum sweep rate per octave.*

There are several parameters to be setup in this application. Move the cursor to highlight the specific parameter to be set, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up an alternate Step Frequency sweep as detailed in Section 2.3.3.
- Set up a dual Power-Frequency sweep

Press [*Alt Sweep*] to configure a second Step or Ramp Frequency sweep that can be run alternately without having to reconfigure each time.

Press [*Dual Sweep*] to configure and run a dual Power-Frequency sweep.

Press [*Trigger Sweep*] to start a frequency sweep or take a single step.

Ramp Frequency Sweep Parameters

Sweep Type:

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp Frequency sweep; see Section 2.3.3 for instructions on how to set up a Step Frequency sweep. With the cursor on Sweep Type, press either Step key to select Ramp.

Parameters:

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop frequencies. Select Center/Span to set up a sweep that allows entering the center frequency

and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of a frequency range.

Start or Center Frequency

When using the Start/Stop option, enter the frequency at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Frequency. Enter the center frequency of the sweep.

Stop Frequency or Frequency Span

When using the Start/Stop option, enter the frequency at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Frequency Span. Enter the total frequency that the sweep will span across.

Sweep Time:

Enter the total time you want for each sweep.

Power Level:

For convenience, you can set the power output level in this menu in the same manner as described in Sections 2.3.1 and 2.3.2.

Repeat Mode:

This option determines how a sweep will run. The choices are Single Sweep or Continuous.

Trigger Type:

Select the type of trigger to be used to initiate the frequency sweep. The options are Immediate, which means a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger in BNC, which will trigger a sweep when a signal is applied to the Trigger BNC from an external source.

2.3.5 Add Markers to a Frequency Sweep

Markers can be added to a sweep in different ways to identify their position in the sweep. Markers can be entered as video, intensity, or amplitude. Video markers illuminate the vertical reticule when the markers are reached. Intensity markers cause the intensity of the sweep to increase when the markers are reached. Amplitude markers generate a blip (positive or negative) when the markers are reached.

To set the markers and their parameters, press [*MARKER*] to bring up the Edit Markers menu shown in Figure 2-13. In this menu illustration, the first two markers have been set at 10.0 and 10.5 GHz, and as Amplitude types, all indicated by the solid white tiles. The cursor is sitting on marker 3.

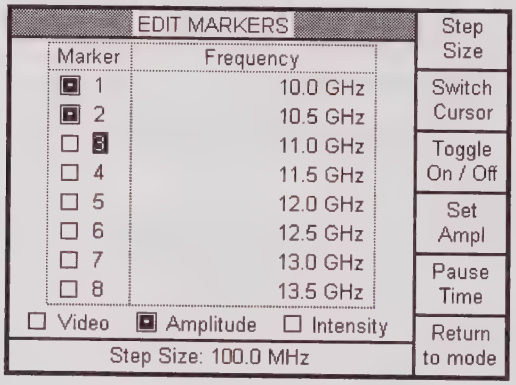

Figure 2-13: Marker Configuration Menu

To set a marker from the Edit Markers menu:

1. Highlight the marker to be set with the cursor and use the keypad to enter the frequency you want to assign to that marker. The digits will display in the bottom window (temporarily replacing the Step Size) as you enter them. Press the appropriate Units key to enter the digits as the marker frequency. You can use the Step Up and Step Down keys to increment and decrement the frequency value by the amount of the current step size.

2. Press [*Switch Cursor*] to move the cursor to the marker type field below the markers. Move the cursor to highlight your desired type of marker and press [*Toggle On/Off*] to turn on the marker type. You can select multiple marker types to apply to a single marker.

   ☛ ***NOTE:*** *Marker Type applies to all active markers, not individually.*

3. Press [*Switch Cursor*] again to move the cursor back to the marker number. Press [*Toggle On/Off*] to turn on the marker, shown by the filled number tile.

4. For amplitude markers, set the amplitude of the marker by pressing [*Set Ampl*] and then setting the value in dBm.

5. For intensity markers, adjust the pause time of the marker by pressing [*Pause Time*] and using the keypad to set the new time. Press the appropriate [*Units*] key to activate the new value. The minimum value must be =>1.0 µs

See Section 2.3.1 for instructions on how to copy a frequency directly from the CW Frequency menu to a marker, or from a marker to the CW Frequency menu.

2.3.6 Set Up a List Frequency Sweep

The List Frequency Sweep is an alternate sweep method that takes full advantage of automatic switching at the highest sweep speed. You can configure up to 99 frequency lists with a variety of points in each, and then allow the instrument to automatically scan through the points. The number of points is limited by the memory of the instrument.

The points that you can set up are the points at which the sweep will stop. Dwell or stop times determine how long the respective sweep will stay at that point. Each point is independent of other points. List sweeps can be set up locally at the front panel or downloaded over the GPIB and run remotely.

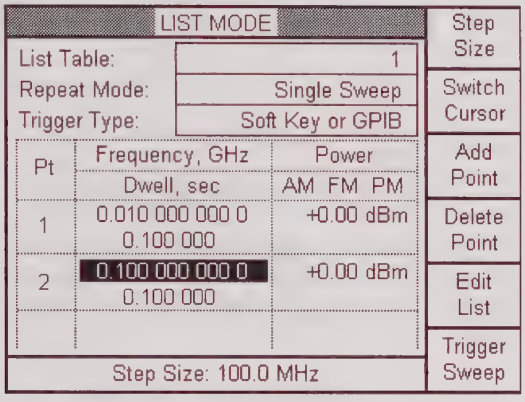

Figure 2-14: List Sweep Configuration Menu

List Table:

Place the highlight on this parameter. You can either press the Step Up or Down key to increment or decrement the list number, or you can enter the list number with the keypad and press any Units key. Each table represents a different sweep configuration; up to 99 lists can be configured. The entries in the table below the parameters are the individual points that can be configured for each sweep.

Repeat Mode:

This parameter sets up the repeat mode of the list sweeps. The options are Continuous, Single-Sweep, or Single Step. Move the cursor to the Repeat Mode and press the Step Up or Down key to select your choice. The modes are defined as follows:

Continuous: Execute the entire current list, repeating it indefinitely.

Single Sweep: Execute the entire current list, and then stop; the next trigger will resume execution at the start of the list.

Single Step: Execute the current list point, and then stop; the next trigger will resume execution with the next list point. The list's first point is considered to be the initial current point, and is also considered to be the point following the list's final point.

Trigger Types:

These are the ways in which the sweep will be initiated. The options are Immediate, Trigger In BNC, and Softkey or GPIB. Move the cursor to this parameter and press the Step Up or Down key for your selection. Immediate mode starts the list as soon as its points are entered. Trigger In BNC requires an external TTL signal to start a sweep (or take a step). Softkey/GPIB triggers a sweep when the front panel softkey is pressed or when a trigger command is received over the GPIB (Get Event).

Configuring Points:

In the table, Pt is the heading for the respective points in the list. Frequency of the point and dwell time at each point are listed in the middle, while power and type of modulation are at the right. The types of modulation will not display in the parameters until you cursor to them and press the Step Up or Down key to activate the selection. You can have any combination of modulations. AM and PM can be used together only when the AM mode is Scan (i.e., AM cannot be linear).

☛ ***NOTE:*** *All points share common AM/FM/PM parameters. These are set up using the AM/FM/PM screens.*

New points can be added by pressing [*Add Point*]. When you add a point, it will be a duplicate of the point on which the cursor is located, so if you want to duplicate a specific point, move the cursor to that point before added the new point. Add Point inserts a point following the current point, and moves other points down the list.

You can edit the points directly in this window by pressing [*Switch Cursor*] to move the cursor to the table, and then move the cursor to highlight the parameter to be changed. Parameters with numerical values are best changed by entering the new value with the keypad and pressing the appropriate Units key. The values can then be fine-adjusted with either the Step keys or the adjusting knob. Modulation parameters are changed by highlighting the *position* of the modulation type and then pressing the Step Up or Down key.

☛ ***NOTE:*** *Points do not have to be entered in any numerical or other order. They can be inserted in any order.*

WARNING

If the power level settings involve changes to the Step Attenuator (i.e., levels below 0 dBm), the List Run time should be closely monitored. The Step Attenuator uses electro-mechanical actuators. These actuators require 25 ms to operate. List Point dwell times should be at least this long. The electro-mechanical actuators have a large, but finite, maximum number of operations. Be sure the List Mode is not left on for long periods of time if the Step Attenuator is being switched.

Existing points can be deleted by first moving the cursor to any parameter within the point, and then pressing [*Delete Point*]. The cursor position identifies the point to be deleted.

Edit List:

Edit List generates a list by specifying the Start, Stop, Step, Dwell, Power Level, and Modulation. The range of the individual lists can be edited by pressing [*Edit List*]. The menu in Figure 2-15 will display.

Press [Insert Range] to generate the list. This can take some time to complete (about 10 ms per point). Once done, the list will appear on the screen. Individual points can now be edited as needed to change common parameters.

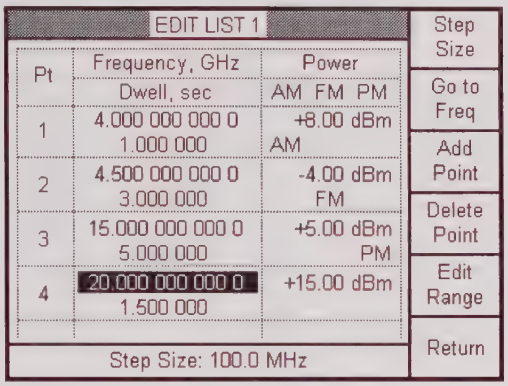

Figure 2-15: Edit List 1 Sweep Parameters Menu

To change range refer to Figure 2-16.

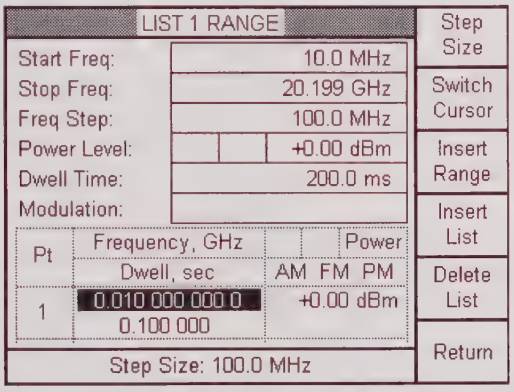

Figure 2-16: List 1 Range Menu

The list number will be displayed in the menu title at the top of the screen. If you need to edit the range of a list other than the one shown, press [Insert List], enter the list number with the keypad and press any Units key. If that list contains no points, it will not display here; you need to go back to the menu in Figure 2-14 and start a new list.

Refer to the instructions on how to configure a Step Frequency Sweep in Section 2.3.3

2.3.7 Speeding Up List Entry

The manipulation (adding, editing, deleting) of large numbers of list points can be speeded up by changing the list trigger mode from the default mode (immediate) to a non-immediate one, e.g.:

- Trigger in BNC

This will relieve the 12000A's firmware of the burden of repeatedly terminating and relaunching list execution in response to each command's arrival, leaving it free to devote itself entirely to command processing. After the list points are manipulated, and their lists precompiled, the trigger mode can be changed as desired.

2.3.8 Precompilation of Lists

In the 12000A, list points exist in two different forms. One is the *source* form, where the data describing a point is in a form that closely corresponds to the human readable formats used by the front panel's list menu. Source form points are *compiled* to create corresponding *object* form points, which are in a format that is understandable to the 12000A's actual signal generation hardware. Normally, compilation is performed during list execution; while point N of a list is being output by the hardware, point N+1 is being compiled by the firmware. The process is invisible to the user, as long as the dwell times of list points are longer than their compilation time (currently about 25 ms a piece). If point dwell times are lower than this value, list execution will be 'slow':

- At the end of a point's dwell time, list execution will pause until next point's compilation is completed.
- If Config | Retrace is set to RF Off, then RF will be blanked during this period.
- If List | Repeat Mode is set to Single Step, trigger events may be missed.

To enable real-time execution of lists with 'short' dwell times, the 12000A contains a feature known as *list precompilation*, which is implemented (when using front panel control) the first time a list is run. Therefore, for maximum speed, manually run the list once after entering the parameters. Allow sufficient time for the precompilation, about 25 ms per point.

Precompilation may need to be repeated whenever:

- Points are added to or removed from the list.
- Points are edited.
- The unit's AC line power is cycled.

2.3.8.1 Multiple Precompiled Lists

The 12000A also supports the precompilation of multiple lists. This can be done by following the single list precompilation procedure for each list of interest.

1. Add and/or edit all the points for all the lists.

2. Run each list.

2.3.9 Storage of List Points

The 12000A allocates storage for list points from pools of memory; thus, the storage requirement for a given number of list points is largely independent of the number of lists in which they are placed. For example, a single list of 100 points requires about the same amount of storage as 10 lists of 10 points each.

Source form points are allocated from nonvolatile memory, so that they will be preserved across cyclings of the unit's AC line power, i.e. across *line power sessions*. This pool of memory is shared by unit setups that are saved via the front panel's System | Store button; nevertheless, there is sufficient space for several thousand points. Object form list points are allocated from volatile memory, i.e. they do not persist beyond the current line power session. Many aspects of the unit's functionality share this pool of memory; therefore, the allocation of an excessive number of object form list points may impair other aspects of the unit's behavior. Deletion of object form list points (see below) may replenish this pool to a state suitable to these other aspects; however, only the cycling of line power is guaranteed to effect a complete replenishment. Currently, we recommend that the number of object form list points be limited to 1000.

The following lists of circumstances are given to help the user insure that the limit on object point quantities can be observed.

Events causing allocation of source form points include:

- The adding of a point.

Events causing their deallocation include:

- The removal of a point.
- The deletion of an entire list.
- Any other event that causes the clearing of nonvolatile memory.

Events causing allocation of object form points include:

- The editing of a source form point.
- The precompilation of a list.
- The running of a list that is not precompiled.

Events causing their deallocation include:

- The deletion of a source form list.
- The cycling of line power.

NOTE: *Lists, when edited or executed, consume object form points, regardless of whether they are precompiled. Also note that the only way to recycle object form points during a given line power session is to delete an entire source form list.*

2.3.10 Configure a Step Power Sweep

Use this feature to set up a step power sweep. Figure 2-17 illustrates the Step Power Sweep menu. A Step Power Sweep will start and stop at the power levels, which you must designate in the configuration along with how a sweep will be repeated. You will also need to configure the dwell time at each step, the output power level and type of trigger to be used.

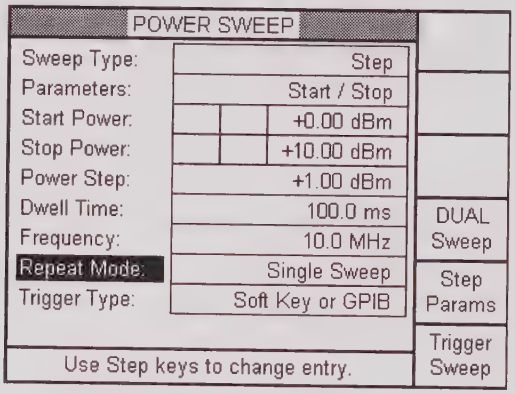

Figure 2-17: Step Power Sweep Configuration Menu

Move the cursor to highlight the specific parameter to be configured, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up a dual Frequency-Power sweep
- Set up the Step Power Sweep parameters

Press [*Dual Sweep*] to configure a dual Frequency-Power sweep.

Press [*Step Perams*] to see the options for selecting the Step/Dwell or Step/Sweep time or the Points/ Dwell or Point/Sweep time.

Press [*Trigger Sweep*] to start a Power sweep after the sweep has been configured.

Step Power Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Step Power sweep. See Section 2.3.11 for instructions on how to set up a Ramp Power sweep. With the cursor on Sweep Type, press either Step key to select Step.

Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop power values. Select Center/Span to set up a sweep that allows you to enter the center level and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of the power range.

Start or Center Power Level

When using the Start/Stop option, enter the power value at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Power. Enter the center value of the sweep.

Stop Power or Power Span

When using the Start/Stop option, enter the value at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Power Span. Enter the total value that the sweep will span across.

Power Step

Enter the value that you want each step of the sweep to take.

Dwell Time

Enter the time you want the sweep to dwell at each step. The dwell time does not include the transition time to arrive at the dwell point.

Frequency

For convenience, you can set the frequency of the Power sweep in this menu in the same manner as described in Sections 2.3.1 and 2.3.2.

Repeat Mode

This option determines how a sweep will run. The choices are Single Step, Single Sweep, or Continuous.

Trigger Type

Select the type of trigger that will be used to initiate the Power sweep. The options are Immediate, which means that a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep or step when either the softkey is pressed or a command is received over the GPIB; and Trigger In BNC, which will trigger a sweep or step when a signal is applied to the Trigger In BNC from an external source.

☛ ***NOTE:*** *The Immediate mode is not valid for a single step sweep or single sweep.*

2.3.11 Configure a Ramp Power Sweep

Use this feature to set up a Ramp Power sweep. Figure 2-18 illustrates the Ramp Power Sweep menu. A Ramp Power sweep starts at a power level, which you must designate, and runs continuously until it reaches a stop level. The Ramp sweep can be run as a single sweep or continuously. There are no step options associated with the Ramp Power Sweep.

CAUTION

Excessive Attenuator Switching will shorten its life (Option 26).

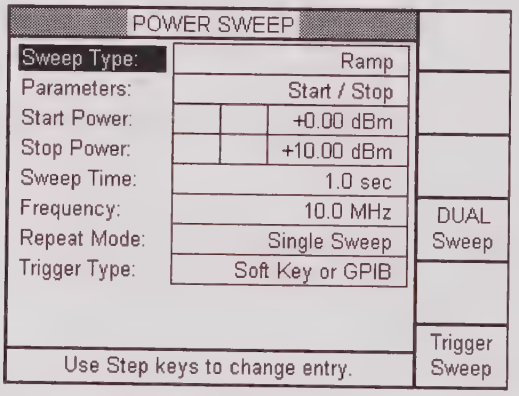

Figure 2-18: Ramp Power Sweep Configuration Menu

There are several parameters to be setup in this application. Move the cursor to highlight the specific parameter to be set, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to set up a dual Frequency-Power sweep (see Section 2.3.11).

Press [*Dual Sweep*] to configure and run a dual Frequency-Power sweep.

Press [*Trigger Sweep*] to start a power sweep or take a single step.

Step Power Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp sweep, see Section 2.3.3 for instructions on how to set up a Step sweep. With the cursor on Sweep Type, press either Step key to select Ramp.

Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop power values. Select Center/Span to set up a sweep that allows entering the center power level and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of the power range.

Start or Center Power Level

When using the Start/Stop option, enter the power value at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Power. Enter the center value of the sweep.

Stop Power or Power Span

When using the Start/Stop option, enter the value at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Power Span. Enter the total value that the sweep will span across.

Sweep Time

Enter the total time you want for each sweep.

Power Level

For convenience, you can set the sweep frequency in this menu in the same manner as described in Sections 2.3.1 and 2.3.2.

Repeat Mode

This option determines how a sweep will run. Single Sweep or Continuous.

Trigger Type

Select the type of trigger to be used to initiate the Power sweep. The options are Immediate, which means a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger in BNC, which will trigger a sweep when a signal is applied to the Trigger BNC from an external source.

2.3.12 ALC Operation

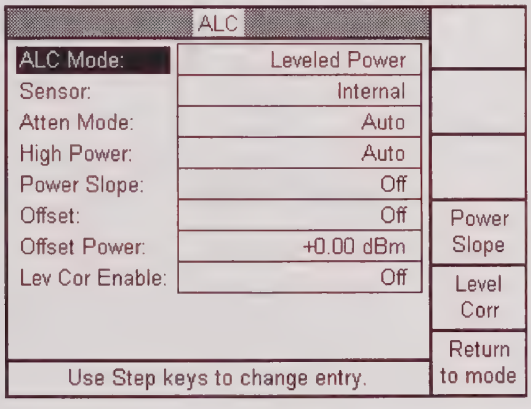

Figure 2-19: Automatic Leveling Control Selection

The ALC menu screen allows controlling the various functions which relate to the setting of the instrument output power. Some of the modes are optional, a few are yet to be released. The descriptions following detail the operation.

ALC Mode:

This field allows choosing between leveled power and maximum power. In the leveled power mode, the output power (modified by the Power Slope and/or Offset parameters) is set by the operator. When Maximum Power is selected, the instrument will produce the highest power possible. The Level LED remains on when in Maximum Power mode.

Sensor:

Currently, only the internal sensor is supported.

Atten. Mode:

This field selects either Automatic or Manual operation of the step attenuator. In Automatic mode, the step attenuator will switch to 10 dB when the set power is between –10 and –.01 dBm. It will continue to increase its attenuation value for each 10 dB 'block' of settings. In Manual mode, the step attenuator may be fixed at any desired setting from 0 to 110 dB. Once this is done, the incremental power adjustment range is –20 to +20 dB. This means that the instrument leveling system is effectively controlling the power from a value of –20 dBm to +20 dBm. Power levels from –20 to –10 dBm may not meet the leveling accuracy specification. Power levels above the specified maximum output for any given frequency may not be attainable.

High Power:

This menu item is only visible if Option 20 has been installed. Option 20 provides additional amplifiers to guarantee +20 dBm minimum output. When the selection is 'Automatic', the high power amplifier will switch in at +15 dBm. This is done to reduce amplifier noise at lower levels. In the 'Disabled' mode, the high power amplifiers never switch in.

Power Slope:

When this function is enabled, the following screen appears:

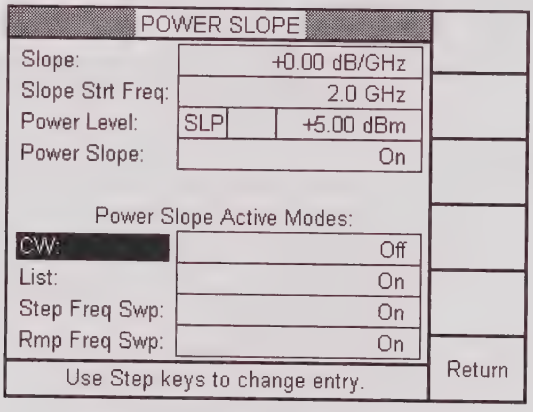

Figure 2-20: Power Slope Selection

The purpose of this function is to allow compensating for losses in some external component, such as a cable. The 'Slope' field defines the amount of change per GHz (the maximum allowed is 8 dB).

☛ ***NOTE:*** *The step attenuator is effectively in manual mode when power slope is on and will not change dynamically!*

The 'Slope Start Frequency' field sets the point at which slope correction begins. The output power then changes at a rate set by the slope variable. The 'Power Level' field is for convenience in setting the global power level variable. Note the letters 'SLP'. These appear in the any menu having a Level field to indicate that Power Slope is enabled.

The lower part of the screen allows selectively applying Power Slope to different modes of instrument operation.

Offset:

Turning on this feature will change the output power by the amount specified in the 'Offset Power' field. The displayed power level in the various menus does not change, however the letters 'OFS' will appear next to the level value to indicate the offset is active. The offset can be as large as the full range of the instrument power, including the step attenuator.

Level Correction:

This feature is not currently supported.

2.3.13 Select the Type of Modulation

Three types of output modulation are available as described below. The modulation selection and parameters will be displayed when you press **[AM]**, **[FM]** or **[PM]** in the Modulation field. You can use any combination of modulation types with the exception that linear AM is not available for use with PM.

Option 24 is available to provide internal AM, FM, or PM.

Refer to the Modulation Parameters and Specifications in Chapter 1 for detailed information.

2.3.13.1 External Amplitude Modulation

- ❖ Linear AM
- ❖ Scan AM

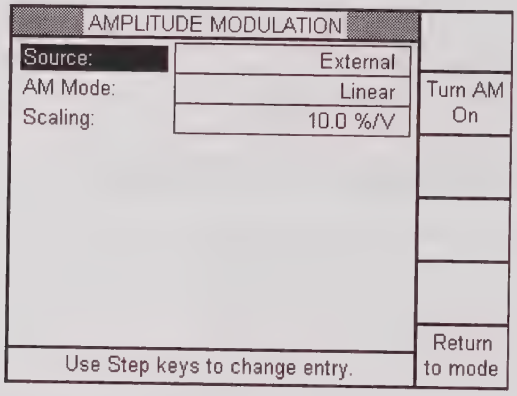

Figure 2-21: Amplitude Modulation Selection

Using Amplitude Modulation

There are two modes of operation for Amplitude Modulation.

Linear AM is characterized by a linear change in the peak-to-peak output voltage for a linear change of the input voltage. This is 'classical' AM. The depth of modulation is expressed in percent. Modulation acceptance of this instrument has a bandwidth of DC to 150 kHz.

☛ ***NOTE:*** *Modulation inputs which are asymmetrical or that have a DC component will shift the carrier power level.*

Scan AM is characterized by a logarithmic change in the RF output level for a linear change in the input voltage. Here the modulation is expressed in dB/volt. This modulation has a bandwidth of DC to 150 kHz. All modulation in this mode is 'downward', that is the carrier power will decrease as the input voltage is increased. To avoid clipping the signal, the input voltage must be offset such that it never exceeds 0 volts. Scan AM is essentially an open loop function. To maintain output amplitude accuracy, the operator should periodically 'force' a level re-calibration by exiting and re-enabling the modulation (use the "Turn AM Off" softkey).

Scaling

When using the Scan AM mode, the scaling parameter determines how much modulation (attenuation) is produced for each volt of input. Note that the maximum input level is 6 volts.

Depth

When using the Linear AM mode, the scaling parameter allows setting the depth of modulation (expressed in %) directly if the input signal is 1 volt ($2V_{p\text{-}p}$). For input levels less than 1 volt (1 volt is the maximum allowed), the depth is scaled appropriately.

Enabling AM

There is a softkey to allow turning AM on and off. When AM is off, the key label will read "Turn AM On". When AM is on, the key will read "Turn AM Off". The LED next to the front panel AM button will illuminate when AM is on.

2.3.13.2 Internal Amplitude Modulation

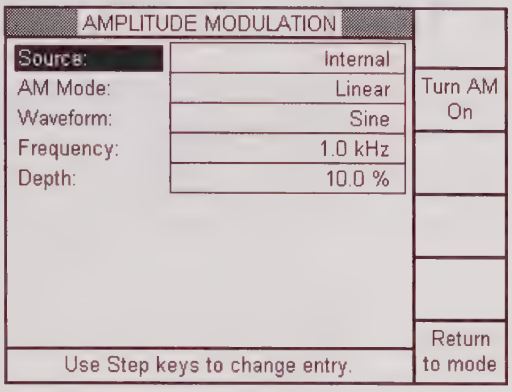

Figure 2-22: Amplitude Modulation Selection - Internal

When option 24 is installed in the instrument, the Amplitude Modulation Screen appears as shown in Figure 2-22. The AM modes of Linear or Scan operate in the same manner as with an external input (refer to section 2.3.13.1). Two new parameters appear: Waveform and Frequency. The Scaling parameter is replaced with a depth parameter.

Waveform:

The Waveform parameter has the following selections:

- Sinewave
- Squarewave
- Triangle wave
- Positive ramp
- Negative ramp
- Gaussian noise
- Modulation off

Each waveform (except the Gaussian noise) is calibrated to have the same peak-to-peak value. The noise output has been bandwidth limited to about 150 kHz and has an peak-to-peak amplitude which is approximately that of the other waveforms. Selecting the Off choice removes the signal from the amplitude modulator but leaves the AM function itself turned on.

The AM Monitor connector on the rear panel provides an approximate 2 V_{p-p} signal which matches the selected waveform.

Frequency:

This parameter field allows setting the modulating signal frequency. The allowable entry range is 0.01 Hz to 1 MHz. Note that the maximum frequency response of the AM functions is 150 kHz. The additional range of the source is for compatibility with the internal FM source.

Depth:

Since the amplitude of the internal source is calibrated (typical for Gaussian noise), the modulation depth may be set directly from the menu. Modulation depth is expressed in % for linear AM and dB for SCAN (logarithmic) AM.

2.3.13.3 External Frequency Modulation

- ❖ Wideband FM
- ❖ Narrowband FM

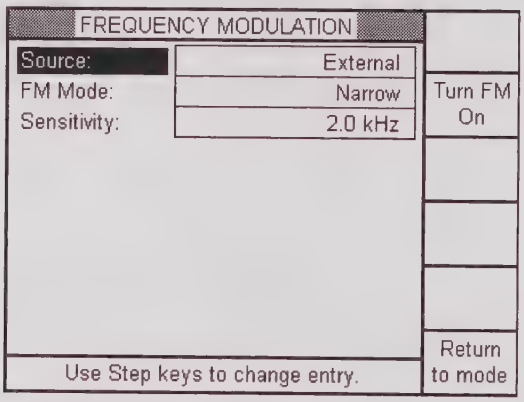

Figure 2-23: Frequency Modulation Selection

Using Frequency Modulation

There are four modes of operation for Frequency Modulation.

In the Narrow mode, the input signal bandwidth is DC to 8 MHz. Applying an input of ± 1 volt will allow the frequency to be shifted by up to ± 1 MHz (4-8 GHz), determined by the sensitivity setting, at any rate from DC to 8 MHz.

☛ ***NOTE:*** *Modulation inputs which are asymmetrical or that have a DC component will shift the carrier frequency*

- The instrument frequency accuracy is a function of both the time base accuracy and the accuracy of the factory DCFM offset calibration. Typical frequency errors due to the DCFM offset are under 10 Hz (in the 4-8 GHz band).
- Phase noise performance is the same as in CW mode. There is, however, some noise generated by the ADC used to digitize the "inside the loop" portion of the modulation. This noise is relatively insignificant compared to the deviation as long as the input voltage is set to 1 volt peak. If, for example, the deviation were set to 1 MHz and no modulating signal were applied, the noise would be noticeable.

In the Wide mode, the input signal bandwidth is 100 Hz to 8 MHz. The maximum deviation for a ± 1 volt input is ± 20 MHz (4-8 GHz).

☛ ***NOTE:*** *Modulation inputs which are asymmetrical will shift the carrier frequency.*

- The loop bandwidth is reduced to below 50 Hz allowing all modulation to be 'outside the loop'. For this reason, the close-in phase noise is degraded.
- If the modulation index is greater than about 10,000 there will be some additional distortion due to excessive phase shift at the phase detector. This is equivalent to a deviation of 10 MHz with a 1 kHz rate.

The two Phase Modulation modes (Wide and Narrow) are provided to allow generation with a constant modulation index. These modes are created by simply differentiating the modulation signal. Therefore all other characteristics of each mode remain the same. The allowable range of modulating frequencies is 10 Hz to 100 kHz for Narrow mode and 100 Hz to 100 kHz for Wide mode.

Sensitivity

This parameter selection allows the user to specify how much deviation is produced for a 1 volt input. The value is the peak deviation. 1 volt is the maximum permitted input level. If less than 1 volt is input, the deviation may be computed by multiplying the input voltage by the displayed deviation setting. Since the instrument uses frequency division, the maximum allowable deviation will be reduced for each octave below 4-8 GHz. The instrument will attempt to maintain the deviation as the frequency is changed but will not exceed a value of (1 MHz/N) where N is the division being used. For example, if a deviation of 100 kHz is entered at 4 GHz then it will be maintained down to a selected frequency of 500 MHz (a division of 8). At 250 MHz, the deviation will be reduced to 62.5 kHz. For frequencies above 8 GHz, the maximum deviation permitted will increase to ± 40 MHz (8-16 GHz) or ± 80 MHz (16-20 GHz).

When using either of the Phase Modulation modes, this parameter field allows setting the modulation index, in radians. Phase modulation has the characteristic of maintaining a constant modulation index (expressed in radians) as the modulating frequency is changed. This makes the deviation smaller as the modulating frequency is reduced. The mathematical expression for this is :

$$\mathbf{M\ (radians) = \Delta F\ (deviation)/F_m\ (modulating\ frequency)}$$

The instrument calibration is such that at a 100 kHz rate, the maximum deviation will be 1 MHz in narrow mode (10 radians) and 20 MHz in wide mode (200 radians). The same constraints relative to carrier frequency apply in Phase Modulation modes.

Enabling FM

There is a softkey to allow turning FM on and off. When FM is off, the key label will read "Turn FM On". When FM is on, the key will read "Turn FM Off". The LED next to the front panel FM button will illuminate when FM is on.

2.3.13.4 Internal Frequency Modulation

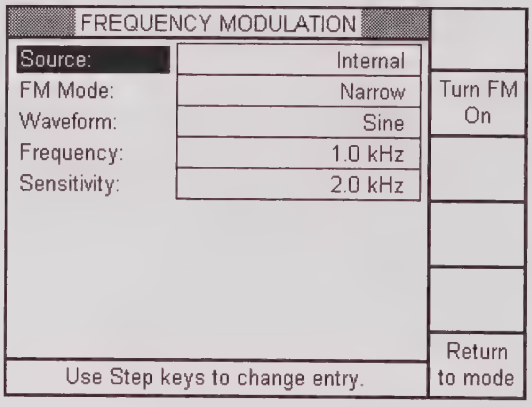

Figure 2-24: Frequency Modulation Selection - Internal

When option 24 is installed in the instrument, the Frequency Modulation Screen appears as shown above. The FM modes of Narrow and Wide operate in the same manner as with an external input (refer to section 2.3.13.3). Two new parameters appear: Waveform and Frequency. The Sensitivity parameter is replaced with a Deviation parameter.

Waveform:

The Waveform parameter has the following selections:

- Sinewave
- Squarewave
- Triangle wave
- Positive ramp
- Negative ramp
- Modulation off

Each waveform is calibrated to have the same peak-to-peak value. Selecting the Off choice removes the signal from the frequency modulator but leaves the FM function itself turned on.

The FM Monitor connector on the rear panel provides an approximate 2 $V_{p\text{-}p}$ signal which matches the selected waveform.

Frequency:

This parameter field allows setting the modulating signal frequency. The allowable entry range is 0.01 Hz to 1 MHz.

Deviation:

This parameter field allows setting the deviation for the frequency modulation. The deviation is set directly since the modulation generator output is a fixed level. The deviation limits are the same as with external modulation.

2.3.13.5 External Pulse Modulation

- ❖ Active High (Positive-going)
- ❖ Active Low (Negative-going)

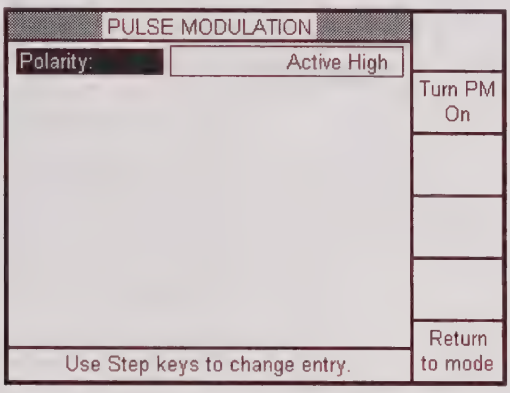

Figure 2-25: Pulse Modulation Selection

Using Pulse Modulation

The Pulse Modulation function allows controlling the instrument RF output with a high speed high on/off ratio level shift (on/off keying). During pulse operation, the RF output will be attenuated from the set level by at least 80 dB when the pulse is 'off'.

Polarity

This parameter determines which polarity of the input signal produces an RF output. Setting the parameter to 'Active High' means that the RF will be on when the input signal is a TTL high.

Enabling PM

There is a softkey to allow turning PM on and off. When PM is off, the key label will read "Turn PM On". When PM is on, the key will read "Turn PM Off". The LED next to the front panel PM button will illuminate when PM is on.

2.3.13.6 Internal Pulse Modulation

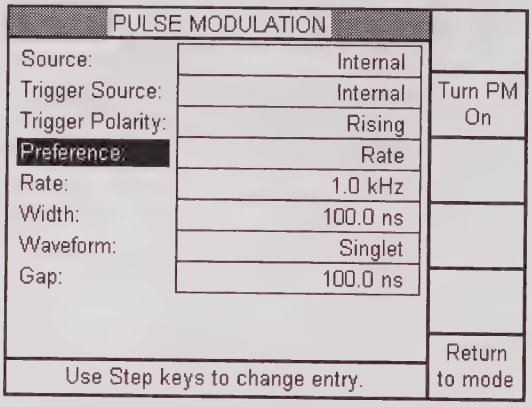

Figure 2-26: Pulse Modulation Selection - Internal

When option 24 is installed in the instrument, the Pulse Modulation screen appears as shown above. The operation of the additional fields is described below.

Trigger Source:

This parameter selects either the rising or the falling edge of an external trigger as the start signal for each pulse. When externally triggered, the internal generator will allow rates of 5 Hz to 5 MHz and will generate the same widths and delays as in internal triggering.

Preference:

This selection field allows two methods for pulse 'timing'. If set to 'Rate', the repetition frequency for the pulse group train (using the internal trigger) may be directly specified. There is no delay setting in this mode. When this field is changed to 'Start Delay', the pulse repetition frequency is implicitly determined by the Delay and Width parameters. Each of these methods can generate the same waveform if the parameters are set appropriately. For example: setting a rate of 1 kHz with a width of 500 µs will produce the same waveform as setting a start delay of 500 µs and a width of 500 µs (assuming a 'singlet' pulse selection). Note that this field is always in the 'Start Delay' mode if the trigger selection is External.

Rate (Start Delay):

This field has two functions depending on the setting of the 'Preference' field (see above). When 'Rate' is displayed, the repetition frequency for the pulse train may be entered directly. The internal pulse generator is capable of generating pulse rates from 1 Hz to 3 MHz with widths of 100 ns to 1.67 seconds. When 'Start Delay' is entered, the time from the trigger (internal or external) to the start of the first pulse in a group may be entered. The delay (referenced to the Sync output) may be set from 0 to 1.67 seconds.

Width:

This entry sets the width of each pulse produced, with either an external or an internal trigger. The width may be set from 100 ns to 1.67 seconds. If the Waveform field is set to one of the multiple pulse selections, each pulse in the group will have the same width.

Waveform:

This parameter determines how many pulses are produced for each trigger (internal or external). The maximum number of pulses per group is four. Each pulse in the group will have the same width. The 'Start Delay' parameter will always be the time from the trigger to the first pulse in the group. See 'Gap', below for a description of the inter-pulse spacing. If the 'Preference' field is set to 'Start Delay' then the effective pulse rate will be determined by adding up the start delay, the width of each pulse in the group, and the gap between any pulses following the first.

Gap:

If a multiple pulse waveform is selected, the spacing between pulses may be selected with this parameter. The delay from the trigger to the first pulse is set by the 'Start Delay' parameter. The spacing from pulse one to pulse two and between pulse two and three and between pulse three and pulse four is set by the 'Gap' parameter. All inter-pulse spaces are identical. The range of values is 100 ns to 1.67 seconds.

3

Remote Operation

3.1 Introduction

The Series 12000A Microwave Synthesizers can be operated from a remote host over the General Purpose Interface Bus (GPIB) using either Standard Commands for Programmable Instruments (SCPI) or Native language commands. Operation via the RS-232 interface is possible using the Native commands.

NOTE: *The unit may be operated via its RS-232 interface, using the same language(s) as are supported on its GPIB interface. Other GPIB functionality, such as that provided by the GPIB lines IFC, SRQ, etc., and by GPIB multiline messages, such as GET, DCL, etc., are not supported over the RS-232 interface. The RS-232 interface's parameters are: 9600 baud, 8 bits per character, 1 stop bit, no parity, and neither software (XON/XOFF) nor hardware (RTS/CTS) flow control. Commands must be terminated with a carriage return. The sending of commands prior to the unit's completion of its powerup initialization is not recommended. The use of both the GPIB and the RS-232 interface at the same time is not allowed.*

3.1.1 Languages Available

All synthesizer functions are designed to be controlled over the General Purpose Interface Bus (GPIB). At present, SCPI and IEEE 488 Native languages are implemented. These languages are introduced briefly below, and discussed in more detail under separate headings.

- Standard Commands for Programmable Instruments (SCPI) is a language specified by the SCPI Consortium. It is designed to standardize commands and data to and from instruments regardless of the manufacturer. SCPI promotes consistency from the remote programming standpoint between instruments, which are of the same class or have the same functional capability. For a given function such as frequency or power, SCPI specifies the command set that is available for that function.
- The Native syntax is a set of IEEE 488 commands developed for remote control of Giga-tronics instruments.

3.2 SCPI Command Codes

The SCPI syntax implemented in the Series 12000A includes the IEEE 488.2 Common commands, status reporting, error reporting, and table-specified defaults at power-up or *RST.

3.2.1 SCPI Command Format

Details of typography (such as indentation, case, and punctuation) are very significant in SCPI and must be attended to with great care. The typographic conventions employed in the SCPI command tables which follow are summarized here.

Colons indicate changes of level in the SCPI tree structure. If a command is represented in the format ALPHA:BETA:GAMMA, then BETA is one level down from ALPHA, and GAMMA is two levels down from ALPHA. If ALPHA is printed at the left margin, ALPHA is at the root level.

Commands can be entered in upper- or lowercase. However, only required letters are in upper case in the command structure. If you enter more than the required letters, you must enter the entire command (e.g., if the command is INITiate, you can use either INIT or INITIATE, but INITI is invalid).

If a command is shown in square brackets, it is an implied command and can be omitted (the brackets are not part of the command and should be omitted even if the command itself is entered). An implied command is the default command among the commands available at its level. For example, in the case of the command INITiate:[IMMediate], the immediate mode is the default mode, so entering INIT has the same effect as entering INIT:IMM.

Because you can query any value that you can set, most commands also exist in a query form (signified by a question mark at the end of the command). Some commands are events that cause something to happen at a particular time but do not create a setting or value to be checked afterwards. Consequently, they have no query form.

Some commands require a parameter. The parameter types are:

Boolean: A Boolean (true or false) condition. Enter

ON or 1 for TRUE
OFF or 0 for FALSE.

NUM_VAL: A numeric value or a qualitative term which represents a numeric value. Enter:

Sign (optional)
value digits
decimal point (optional)
E xx (optional)
units suffix (optional).

Or enter

MIN or MAX
UP or DOWN (these only change the synthesizer's output frequency or output power level).

NUM: A number, which typically represents register bit settings in the form of a decimal integer.

There are also discrete parameters. These are options to be chosen from a limited selection. For example, the TRIGger:SLOPe command has three possible discrete parameters to chose from (POSitive, NEGative, and NONe).

The beginning of a parameter must be preceded by a space. The default units suffixes are DB for power and HZ for frequency (optional parameters for frequency are KZ, MZ and GZ).

3.2.2 SCPI Mandated Commands

The following are SCPI mandated commands. The command syntax is followed by a description of the command. Many of these commands refer to the Status System, which is discussed in detail in Section 3.2.4. Commands beginning with an asterisk are IEEE 488.2 Common Commands.

- ***CLS**
- ***ESE**
- ***ESE?**
- ***ESR?**
- ***IDN?**
- ***OPC**
- ***OPC?**
- ***RCL**
- ***RST**
- ***SAV**
- ***SRE**
- ***SRE?**
- ***STB?**
- ***TST?**

*CLS

Syntax: *CLS

Description: Clear Status. This command clears the event registers in all status groups. It also clears the Event Status Register and the Error/Event Queue.

*ESE

Syntax: *ESE

Description: Standard Event Status Enable. This command makes it possible for specified changes in the Standard Event Status Register to generate service requests.

*ESE?

Syntax: *ESE?

Description: This query command determines which changes in the Standard Event Status Register have been enabled to generate service requests. The parameter is a decimal number which represents the register's bit settings.

*ESR?

Syntax: *ESR?

Description: Standard Event Status Register query. This command causes the event register of the Standard Event Status Register group to be read and transmitted over the bus, It also causes the register to be cleared.

*IDN?

Syntax: *IDN?

Description: Identification query. The response takes the form of four ASCII fields separated by commas. The fields are: (1) Manufacturer, (2) Model, (3) Serial Number, and (4) Firmware Level or Equivalent. Fields 1 and 2 are required; fields 3 and 4 are filled by zeros if the data is not available.

*OPC

Syntax: *OPC

Description: Operation Complete. This command causes the Operation Complete bit (that is, Bit 0 of the Standard Event Status Register) to be set to 1 when all pending selected device operations have been finished.

*OPC?

Syntax: *OPC?

Description: This query form places an ASCII character 1 into the device's output queue when all pending selected device operations have been finished. Unlike the *OPC command, the *OPC? query does not affect the OPC Event bit in the Standard Event Status Register (ESR).

*RCL

Syntax: *RCL *n*

Description: TBA

*RST

Syntax: *RST

Description: The Reset command sets the device-specific functions to a known state (the power-on state) that is independent of the past-use history of the device. The command does not reset any part of the status reporting system.

*SAV

Syntax: *SAV *n*

Description: TBA

*.SRE

Syntax: *SRE

Description: The Service Request Enable command makes it possible for service requests to be generated by specified bits of the Status Byte Register.

*SRE?

Syntax: *SRE?

Description: This query command determines which bits of the Status Byte Register have been enabled to generate service requests.

*STB?

Syntax: *STB?

Description: The Status Byte query command causes the event register of the Status Byte Register group to be read and transmitted over the bus. It also causes the register to be cleared.

*TST?

Syntax: *TST?

Description: The Self-Test query command causes the synthesizer to perform a self-test routine. See the notes below concerning Self-Test. The Self-Test routine will preserve (save and later restore) these states:

RF On/Off State
CW Frequency Value
Power Level Coarse Value
Power Level Fine Value

The test routine will then switch in the maximum step attenuation before beginning the test to prevent damage to any user circuitry at the RF output connector. The Power Level (Fine) value during the test will be the maximum output value for the unit (usually +10 dBm), but the Power Level (Coarse) value is set to -110 dB. The output power at the RF connector is the sum of the two, which is still so small that it presents no risk of damage to connected devices.

The synthesizer will go to TEST:FREQuency:BEGin (the default value is the minimum frequency) and check for lock and level. If lock and level are OK, the frequency increment specified by TEST:FREQ:STEP (default: 1 GHz) will be added in order to calculate the next frequency, and the lock and level checks will be made again. If the calculated frequency exceeds TEST:FREQuency:END, the synthesizer will be set to that end frequency instead.

If there are no errors, the test ends when the frequency just tested equals the frequency specified by TEST:FREQuency:END. The saved entry states are restored, and a value of 0 is returned.

If there are errors, the test stops at the frequency where the errors occurred and saves that frequency as TEST:FREQuency:QUIT. The saved entry states are restored and a decimal error code is returned. To determine which bits are ON from the decimal error code, refer to Registers, Bit Numbers and Decimal Weights (Section 3.3.2). The bit meanings are:

Bit 0: Main PLL lock status
Bit 1: Tracking PLL lock status
Bit 2 through Bit 6:(not used)
Bit 7: Level Control leveled/unleveled status

If you inadvertently enter a very small step size and then start the test running, the TEST:ABORt command provides a means of terminating the test before completion. The test is simply stopped. Even though you had issued the *TST? command (a query), no reply will occur after abort. You must manage the clearing of your expected reply.

For any of the above outcomes, a query of TEST:FREQuency:QUIT? will give the value of the last frequency used in the test.

*WAI

Syntax: *WAI

Description: Wait-to-Continue. This command prevents the instrument from executing any further commands or queries until all pending selected device operations have been finished. The *RST and *CLS commands have no effect on the operation of the *WAI command.

OUTPut

Syntax: OUTPut[:STATe]

Example: OUTPut:OFF

Description: This command activates or deactivates the synthesizer RF output.

OUTPut?

Syntax: OUTPut?

Description: This query command reports the ON/OFF status of the RF output.

3.2.3 SCPI SOURCe Commands

SCPI Source commands are divided into the sections listed below. In some cases the Source code may contain additional sets of functions. All Source subsystem commands begin with [SOURce], but as [SOURce] is the default command at the root level it need not be entered. The following SOURce subsystems are used in the 12000A:

- **AM**
- **FM**
- **FREQuency**
- **LIST**
- **MARKer**
- **POWer**
- **PULM**
- **SWEep**

AM Subsystem Commands

The Amplitude Modulation subsystem sets the modulation controls and the parameters associated with the modulating signal(s).

- **AM[:DEPTh]**
- **AM:INTernal:FREQuency**
- **AM:STATe**
- **AM:SOURc:EXTernal**
- **AM:TYPE**

AM[:DEPTh]

Syntax: AM <*Num_Val*>

Example: AM 40 ! Set the AM depth to 40%

Description The AM:DEPTh command selects the source of modulation and sets the modulation depth to a percentage value.

AM:INTernal:FREQuency

Syntax: AM:INTernal:FREQuency <*Num_Val*>

Example: AM:INTernal:FREQuency 1000 ! Set the internal AM rate to 1000 Hz

Description: Sets the rate of the internal amplitude modulation generator. The unit for the frequency is Hertz (Hz). If no value is entered, it is assumed to be 1 Hz. This command is valid only when Option 24 is installed.

AM[:STATe]

Syntax: AM <*Boolean*>

Example: AM ON (*or* OFF) ! Turn the AM output ON (*or* OFF)

Description: This command activates or deactivates the AM mode.

AM:SOURce:EXTernal

Syntax: AM:SOURce:EXTernal <*Boolean*>

Example 1: AM:SOURce:EXTernal ON ! Select a single external modulation source.

Example 2: AM:SOURce:EXTernal 1 ON, EXTernal 2 ON! Select two external modulation sources.

Description: Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.

AM:TYPE

Syntax: AM:TYPE <*Boolean*>

Example: AM:TYPE LOGarithmic ! Select LOGarithmic AM shaping

Description: This command controls the AM shaping. The default is LINear.

LINear = The output voltage is directly proportional to V_{mod}.

LOGarithmic = The output voltage is proportional to log (V_{mod}).

EXPonential = The output voltage is proportional to 10 (V_{mod}).

FM Subsystem Commands

The Frequency Modulation command subsystem sets the modulation controls and the parameters associated with the FM signal(s). The FM commands used in the 12000A are:

- **FM[:DEViation]**
- **FM:INTernal:FREQuency**
- **FM:INTernal:FUNCtion**
- **FM:SENSitivity**
- **FM:SOURce**
- **FM:STATe**
- **FM:TYPE**

FM[:DEViation]

Syntax: FM <*Num_Val*>

Example: FM 100 ! Set the FM deviation to 100 Hz

Description: This command sets the modulation deviation of an FM signal. The unit for deviation is Hertz (Hz).

FM:INTernal:FREQuency

Syntax: FM:INTernal:FREQuency <*Num_Val*>

Example: FM:INTernal:FREQuency 1000 ! Set the internal FM rate to 1000 Hz

Description: Sets the rate of the internal frequency modulation generator. The unit for the internal frequency is Hertz (Hz). This command is valid only when Option 24 is installed.

FM:STATe

Syntax: FM:STATe <*Boolean*>

Example: FM:STATe ON (*or* OFF) ! Turn the FM output ON (*or* OFF)

Description: This command activates or deactivates the FM mode.

FM:TYPE

Syntax: FM:TYPE <*Boolean*>

Example: FM:TYPE TBA ! TBA

Description: TBA

FM:SENSitivity

Syntax: FM:SENSitivity <*Num_Val*>

Example: FM:SENSe 10 ! Set the FM sensitivity to 10 Hz/volt

Description: This command controls the modulation deviation by setting a sensitivity Modulation to the modulation voltage level. The unit for SENSitivity is Hertz/volt (Hz/V).

FM:SOURce

Syntax: FM:SOURce INTernal|EXTernal (EXTernal|INTernal)

Example: FM:SOURCe EXTernal ! Select the FM signal source

Description: Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.

FM:INTernal:FUNCtion

Syntax: FM:INTernal:FUNCtion <Boolean>

Example: FM:INTernal:FUNCtion TBA !

Description: TBA

FREQuency Subsystem Commands

The Frequency subsystem commands control the frequency sweep characteristics of the 12000A. This subsystem includes the following commands:

- **FREQuency[:CW|:FIXed]**
- **FREQuency[:CW|:FIXed]?**
- **FREQuency[:CW|:FIXed]:RES**
- **FREQuency[:CW|:FIXed]:STEP**
- **FREQuency[:CW|:FIXed]:STEP[:INCRement]**
- **FREQuency[:CW|:FIXed]:STEP[:INCRement]?**
- **FREQuency:CENTer**
- **FREQuency:CENTer?**
- **FREQuency:MODE**
- **FREQuency:SPAN**
- **FREQuency:SPAN?**
- **FREQuency:STARt**
- **FREQuency:STARt?**
- **FREQuency:STOP**
- **FREQuency:STOP?**

FREQuency[:CW|:FIXed]

Syntax: FREQuency <*Num_Val*>

Example: FREQuency 1000 ! Set the unit to CW frequency of 1000 HZ

Description: The CW or FIXed mode selects a frequency of a non-swept signal. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.

FREQuency[:CW|:FIXed]?

Syntax: FREQuency?

Description: This command queries and reports the current CW/Fixed frequency.

FREQuency[:CW|:FIXed]:RES

Syntax: FREQuency:RES <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: FREQuency:RES 100 ! Set the CW frequency resolution to 100 Hz

Description: This command sets the absolute increment/decrement at which the frequency of the output signal can be changed. The default value is HZ.

FREQuency[:CW|:FIXed]:STEP

Syntax: FREQuency:STEP <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: FREQuency:STEP 100 HZ ! Set the sweep frequency step to 100 Hz

Description: This command specifies a sweep frequency step size. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.

FREQuency[:CW|:FIXed]:STEP[:INCRement]

Syntax: FREQuency:STEP[:INCRement] <*Num_Val*>

Example: FREQuency:STEP 100 ! Set the sweep frequency step size to 100 Hz

Description: This command specifies a step size for sweeping or for UP/DOWN incrementing. The unit value is Hertz. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.

FREQuency[:CW|:FIXed]:STEP[:INCRement]?

Syntax: FREQuency:STEP?

Description: The is the query form to report the CW/Fixed frequency step increment size.

FREQuency:CENTer

Syntax: FREQuency:CENTer <*Num_Val*>

Example: FREQuency:CENTer 100 MZ ! Set the center frequency to 100 MHz

Description: This command sets the CENTer frequency of a sweep. The default unit is MZ; additional unit options are HZ, KZ and GZ.

FREQuency:CENTer?

Syntax: FREQuency:CENTer?

Description: This is the query form to report the center frequency.

FREQuency:MODE

Syntax: FREQuency:MODE CW|FIXed|SWEep|LIST|SENSe

Example 1: FREQuency:MODE CW ! Set the CW commands to control the ! frequency subsystem

Example 2: FREQuency:MODE LIST ! Set the List commands to control the ! frequency subsystem

Description: This command establishes which set of commands will be used to control the frequency subsystem. The settings have the following meanings:

CW|FIXed: The frequency is determined by FREQuency[:CW] or [:FIXed]. CW and FIXed are interchangeable, both must be implemented if either is implemented.

SWEep: The source is in the swept mode and the frequency is determined by FREQuency:STARt, STOP, CENTer, SPAN, and MAN (manual).

LIST: The source is in the LIST sequence mode and the frequency is determined by LIST:FREQuency (refer to the LIST subsystem commands in this section).

SENSe: The source is coupled to the sensor. All frequency controls are determined by the SENSe:FREQuency block, except for OFFSet and MULTiplier. These two commands remain active under SOURce to allow for offset and harmonic tracking.

FREQuency:SPAN

Syntax: FREQuency:SPAN <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: FREQuency:SPAN 200 MZ ! Set the frequency span to 200 MHz

Description: This command sets the sweep frequency span.

FREQuency:SPAN?

Syntax: FREQuency:SPAN?

Description: This is the query form to report the SPAN of the sweep frequency.

FREQuency:STARt

Syntax: FREQuency:STARt <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: FREQuency:STARt 200 HZ ! Set the sweep starting frequency to 200 kHz

Description: This command sets the STARt frequency. It also sets the lower limit of a manual sweep.

FREQuency:STARt?

Syntax: FREQuency:STARt?

Description: This is the query command to report the STARt frequency.

FREQuency:STOP

Syntax: FREQuency:STOP <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: FREQuency:STOP 100 MZ ! Set the sweep stop frequency to 100 MHz

Description: This command sets the STOP frequency. It also sets the upper limit of a manual sweep.

FREQuency:STOP?

Syntax: FREQuency:STOP?

Description: This is the query command to report the STOP frequency.

LIST Subsystem Commands

- **LIST:DWELI**
- **LIST:DWELI:POINts?**
- **LIST:FREQuency**
- **LIST:FREQuency:POINts?**
- **LIST:POWer**
- **LIST:POWer:POINts?**

LIST:DWELI

Syntax: LIST:DWELI <*Num_Val*>

Example: LIST:FREQuency 100 ! Set the dwell time for points in the current lists 100 ms

Description: This command specifies the dwell time for points in the current lists. The default value is in alternate values.

LIST:DWELI:POINts?

Syntax: LIST:DWELI:POINts?

Description: This command returns the number currently in the DWELI lists.

LIST:FREQuency

Syntax: LIST:FREQuency <*Num_Val*>| <*Num_Val*>

Example: LIST:FREQuency 100 ! Set the points in the current lists to 100 Hz

Description: This command sets the value of the next frequency (index numbers 0 - 9) on the list in memory. The default index is 0. When a value is entered, the index automatically increments, up to a ceiling value of 9.

LIST:FREQuency:POINts?

Syntax: LIST:FREQuency:POINts?

Description: This command returns the points currently in the FREQuency list.

LIST:POWer

Syntax: LIST:POWer <*Num_Val*>

Example: LIST:POWer -10 ! Set the points in the current lists to -10 dB

Description: This command specifies the power/amplitude points in the lists.

LIST:POWer:POINts?

Syntax: LIST:POWer:POINts?

Description: This command returns the number of points currently in the POWer list.

MARKer Subsystem Commands

- **MARKer:AMPLitude**
- **MARKer *n*:FREQuency*n***
- **MARKer:FREQuency?**

MARKer:AMPLItude

Syntax: MARKer:AMPLitude <*Boolean*>

Example: MARKer:AMPLitude ON ! Set the Marker Amplitude ON

Description: This command controls whether the marker affects the signal. If ON, the signal is modified when the marker frequency equals the output frequency. If OFF, only the marker output port is affected.

MARKer:FREQuency

Syntax: MARKer <*Num_Val*>:FREQuency <*Num_Val*>

Example: MARKer 3:FREQuency 1000

Description: This command controls the absolute frequency of the specified marker when MARKer:MODE is FREQuency. When MARKer:MODE is DELTa, the command controls the relative frequency.

MARKer:FREQuency?

Syntax: MARKer:FREQuency?

Description: This command returns the frequency in the current MARKer list.

POWer Subsystem Commands

- **POWer:ATTenuation**
- **POWer:ALC[:STATe]**
- **POWer:ALC:SOURce:INTernal**
- **POWer[:LEVel][:IMMediate][:AMPlitude]**
- **POWer[:LEVel][:IMMediate][:AMPlitude]?**
- **POWer[:LEVel][:IMMediate][:Amplitude]:STEP**
- **POWer:MODE**
- **POWer:STARt**
- **POWer:STOP**

POWer:ATTenuation

Syntax: POWer:ATTenuation <*Num_Val*>

Example: POWer:ATTenuation -10 DB! Set the power attenuation to -10 dBm

Description: This command sets the power attenuation level in dB

POWer:ALC[:STATe]

Syntax: POWer:ALC <*Boolean*>

Example: POWer: ALC ON ! Turn on the Automatic Leveling Control

Description: This subsystem command enables or disables the Automatic Leveling Control of the generator.

POWer:ALC:SOURce:INTernal

Syntax: POWer:ALC:SOURce:INTernal DIODe|PMETer

Description: This DIODe subsystem command directs the ALC feedback to be fed from an external diode detector. The PMETer subsystem command directs the ALC feedback to be fed from a power meter DC output.

POWer[:LEVel][:IMMediate][:AMPlitude]

Syntax: POWer <*Num_Val*>

Example: POWer -10 ! Set the unswept output signal to -10 dBm

Description: This command sets the magnitude of the unswept output signal in terms of the current operating units. The units are the default value or can be set to a different value under the UNIT subsystem. The AMPLitude specifies the level for either a time varying or non-time varying signal.

POWer[:LEVel][:IMMediate][:Amplitude]:STEP[:INCRement]

Syntax: POWer:STEP <*Num_Val*>

Example: POWer:STEP -10 ! Set the power step to -10 DB

Description: This command specifies the power step size in dB for UP/DOWN incrementing.

POWer[:LEVel][:IMMediate][:Amplitude]:STEP?

Syntax: POWer:STEP?

Description: This query form discovers the present step size.

POWer:MODE

Syntax: POWer:MODE FIXed|SWEep|LIST

Example 1: POWer:MODE SWEep ! Set the SWEep commands to control the amplitude ! subsystem

Example 2: POWer:MODE LIST ! Set the List commands to control the amplitude ! subsystem

Description: This command establishes which set of commands will be used to control the amplitude subsystem. The settings have the following meanings:

FIXed: The power amplitude is determined by the LEVel command under the appropriate subsystem.

SWEep: The source is in the swept mode and the amplitude is determined by STARt, STOP, CENTer, SPAN, and MANual commands under the appropriate subsystem.

LIST: The source is in the LIST mode and the amplitude is determined by the appropriate amplitude list, such as LIST (refer to the LIST subsystem commands in this section).

POWer:STARt

Syntax: POWer:STARt

Example: POWer:STARt 5 ! Set the sweep starting power to 5 dB

Description: This command sets the STARt power level. It also sets the lower limit of a manual sweep.

POWer:STOP

Syntax: POWer:STOP <*Num_Val*>

Example: POWer:STOP -7 ! Set the sweep stop power level to -7 dB

Description: This command sets the STOP power level. It also sets the upper limit of a manual sweep.

PULSe Subsystem Commands

- **PULSe:DELay**
- **PULS.FREQuency**
- **PULS:WIDTh**

PULS.DELay

Syntax: PULS:DELay <*Num_Val*> [S|MS|US]

Example: PULM:DELay 10 ! Set the pulse delay to 10 seconds

Description: This commands sets the time from the start of the period to the first edge of the pulse. The default unit is seconds.

PULS.FREQuency

Syntax: PULS:FREQuency <*Num_Val*> [HZ | KZ | MZ | GZ]

Example: PULM:SOURce 10 MZ ! Set the pulse generation to 10 MZ

Description: This commands sets the frequency of the pulse generation

PULS:WIDTh

Syntax: PULS:WIDTh <*Num_Val*> [S|MS|US]

Example: PULS:WIDTh 10 ! Set the pulse generation to 10 seconds

Description: This command sets the period of pulse waveform. The default unit is seconds.

PULse Modulation Subsystem Commands

- **PULM:SOURce**
- **PULM::STATe**

PULM:SOURce

Syntax: PULM:SOURce EXTernal|INTernal

Example: PULM:SOURce EXTernal ! Select an EXTernal PM source

Description: This command selects the source for modulating the signal; it may specify a single or multiple sources. The specified sources in the command are turned on. Any source from a previous selection are ignored.

When multiple sources are available, individual INTernal sources may be distinguished by a unique numeric suffix. It as suffix is not added, the number 1 is assumed.

PULM::STATe

Syntax: PULM:STATe <*Boolean*>

Example: PULM:STATe ON (*or* OFF) ! Turn Pulse Modulation ON or OFF

Description: This command turns Pulse Modulation ON or OFF Turning PM ON does not automatically turn OFF any other type of modulation.

SWEep Subsystem Commands

- **SWEep:FREQuency:COUNt**
- **SWEep:FREQuency:DWELl**
- **SWEep:FREQuency:GENeration**
- **SWEep:FREQuency:STEP**
- **SWEep:FREQuency:TIME**
- **SWEep:POWer:COUNt**
- **SWEep:POWer:DWELl**
- **SWEep:POWer:STEP**
- **SWEep:POWer:TIME**

To use the SWEep:FREQuency and SWEep:POWer commands, you must first set the instrument to the appropriate control. Refer to :MODE under the FREQuency and POWer Subsystem Commands in earlier sections of this chapter.

SWEep:FREQuency:COUNt

Syntax: SWEep:FREQuency:COUNt <*Num_Val*>

Example: SWEep:FREQuency:COUNt 10 ! Set the number of sweeps to 10

Description: This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.

SWEep:FREQuency:DWELl

Syntax: SWEep:FREQuency:DWELl <*Num_Val*>

Example: SWEep:FREQuency:DWELl 10 NS ! Set the dwell time to 10 nanoseconds

Description: This command controls the amount of time spent at each point during a sweep. Note that this value cannot exceed :TIME:POINts.

SWEep:FREQuency:GENeration

Syntax: SWEep:FREQuency:GENeration STEPped|ANALog

Example: SWEep:FREQuency:GENeration ANALog ! Select an analog sweep

Description:This command selects either a stepped or analog sweep.

SWEep:FREQuency:STEP

Syntax: SWEep:FREQuency:STEP <*Num_Val*>

Example: SWEep:FREQuency:STEP 10 ! Set the STEP frequency to 10 HZ

Description: This command controls the swept entity step size for a stepped linear sweep. This parameter is not used if generation is analog or if spacing is logarithmic.

SWEep:FREQuency:TIME

Syntax: SWEep:FREQuency:TIME <*Num_Val*>

Example: SWEep:FREQuency:TIME 10 MS ! Set the sweep duration to 10 microseconds

Description: This command set the duration of the sweep. This command does not turn sweeping on.

SWEep:POWer:COUNt

Syntax: SWEep:POWer:COUNt <*Num_Val*>

Example: SWEep:POWer:COUNt 10 ! Set the number of sweeps to 10

Description: This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.

SWEep:POWer:DWELl

Syntax: SWEep:POWer:DWELl <*Num_Val*>

Example: SWEep:POWer:DWELl 10 NS ! Set the dwell time to 10 nanoseconds

Description: This command controls the amount of time spent at each point during a sweep. Note that this value cannot exceed :TIME:POINts.

SWEep:POWer:STEP

Syntax: SWEep:POWer:STEP <*Num_Val*>

Example: SWEep:POWer:STEP -5 ! Set the power step time to -5 dB

Description: This command controls the swept entity step size for a stepped power sweep.

SWEep:POWer:TIME

Syntax: SWEep:POWer:TIME <*Num_Val*>

Example: SWEep:POWer:TIME 10 MS ! Set the sweep duration to 10 microseconds

Description: This command sets the duration of the sweep. This command does not turn sweeping on.

SYSTem Subsystem Commands

- **SYSTem:ERRor?**
- **SYSTem:KEY**
- **SYSTem:KLOCk**

SYSTem:ERRor?

Syntax: SYSTem:ERRor?

Description: This command returns all error codes currently in the event status registers.

SYSTem:KEY

Syntax: SYSTem:KEY *<Num_Val>*

Description: The KEY mode is a limited implementation of the naming conventions subsystem described in SCPI handbook Volume 1: Syntax and Style.

SYSTem:KLOCk

Syntax: SYSTem:KLOCk *<Boolean>*

Example: SYSTem:KLOCk 1 (or 0)! Lock (1) (or unlock) the front panel knob

Description: This system command locks and activates/deactivates the front panel knob.

TRIGger Subsystem Commands

- **TRIGger:IMMediate**
- **TRIGger:SOURce**

TRIGger:IMMediate

Syntax: TRIGger:IMMediate

Description: This command initiates an immediate sweep cycle and return to IDLE when complete. This command will have no effect if the cycle is set to CONTinuous.

TRIGger:SOURce

Syntax: TRIGger:SOURce IMMediate|BUS|EXTernal

Example: TRIGger:SOURce IMM ! Set the TRIGger cycle to IMMediate

Description: This command selects the source for the event. Only one source may be specified in the parameter at a time for a given event. The sources are:

IMM: The event occurs immediately.

BUS: The source is signal-specific to the control interface.

EXT: An external signal jack is selected as the source. If no suffix is specified in the command, EXTernal is assumed.

3.2.4 SCPI Status Commands

All commands in Table 3-1 relate to the status monitoring system and read from and/or write to the various status group registers. The event and condition registers are read-only. The enable registers and transition filters are read/write. Each status group's transition filter actually contains two filters, one to detect positive-going transitions (PTR) and one to detect negative-going transitions (NTR). Data is in the form of a decimal number, which (when decoded to an 8-bit binary number) indicates the On/Off status of individual data bits.

Table 3-1: SCPI Status Commands

Keyword	Parameter Type	Initial Value	Query Form?
STATus :OPERation [:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:OPERation commands relate to the registers of the operational status group.			
STATus :QUEStionable	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable commands relate to the registers of the questionable status group.			
STATus :QUEStionable :POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			

Table 3-1: SCPI Status Commands (Continued)

Keyword	Parameter Type	Initial Value	Query Form?
STATus :QUEStionable :POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition			
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			
STATus :QUEStionable :FREQuency	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:FREQuency commands relate to the registers of the questionable frequency status group.			
STATus :PRESet	none	none	no query
The STATus:PRESet command restores all parts of the status monitoring system to the power-on/reset condition.			
SYSTem :ERRor?			
:VERSion?			
The SYSTem:ERRor command reads the Error/Event Queue. The SYSTem:VERSion command discovers the release number of the installed firmware.			
:LANGuage			
This command switches from the SCPI syntax to the CIIL or HP syntax. The appropriate commands within those syntaxes must be used to restore the SCPI syntax.			
:LANGuage:HP (command line)			
This command issues an HP-syntax command line for immediate execution from within SCPI without leaving the SCPI syntax. It is useful primarily for sending an LAx command to change the local address to which the Giga-tronics controller sends subsequent commands. However, any valid HP-syntax command line can be entered including multiple commands separated by semicolons. NOTE: Some HP-syntax commands cause characters to be returned to the controller.			

Table 3-1: SCPI Status Commands (Continued)

Keyword	Parameter Type	Initial Value	Query Form?
TEST [:FREQuency] [:QUIT?]			
:BEGin			
:END			
:STEP			
These commands specify or discover frequency-related factors for the self-test routine (see the *TST? query). The TEST[:FREQuency][:QUIT?] query is used after a test has been run to identify the frequency at which the test concluded. The TEST[:FREQuency]:BEGin command specifies the starting frequency of the test. The query form (TEST[:FREQuency]:BEGin?) discovers the starting frequency. The TEST[:FREQuency]:END command specifies the ending frequency of the test. The query form (TEST[:FREQuency]:END?) discovers the ending frequency. The TEST[:FREQuency]:STEP command specifies the frequency step size for the test. The query form (TEST[:FREQuency]:STEP?) discovers the step size.			
TEST :POWer [:FINe]			
:COARse			
These commands set up the conditions of the self-test routine (see the *TST? query). The TEST:POWer[:FINe] command specifies the fine power setting for the test in dB. The query form (TEST:POWer[:FINe?) discovers the fine power setting. The TEST:POWer:COARse command specifies the coarse power setting for the test in dB. The query form (TEST:POWer:COARse?) discovers the coarse power setting.			
TEST :ABORt			
This command halts the self-test routine (see the *TST? query).			
TRIGger [:IMMediate]			
:SLOPe			
The trigger commands specify the execute mode (the method of triggering a process). The applicable process in the Series 50000B is a frequency sweep.			

3.2.5 Sample SCPI Commands

Table 3-2 shows some examples of brief SCPI commands:

Table 3-2: Sample SCPI Commands

Command	Meaning
*IDN?	Query instrument identification (response format: maker,model,serial#,firmware version; (sample response: Giga-tronics,12000A,048256,75).
*RST	Reset system.
OUTP OFF	Turn off RF output.
AM:STAT OFF	Turn off external amplitude modulation.
AM:STAT?	Query external amplitude modulation (sample response: 0).
POW -9.2	Set output power to -9.2 dBm.
POW?	Query output power (sample response: -9.2).
FM:STAT OFF	Turn off external frequency modulation.
FM:STAT?	Query external frequency modulation (sample response: 0).
FREQ 6.1GHZ	Set output frequency to 6.1 GHz
FREQ?	Query output frequency (sample response: 6100000000).
PULM:STAT OFF	Turn off external pulse modulation.
PULM:STAT?	Query external pulse modulation (sample response: 0).

3.3 SCPI Status System

3.3.1 Introduction

The SCPI standard includes a system for monitoring the status of the instrument. Much of this status system is imported from the IEEE 488.2 standard. Status monitoring is accomplished by means of several registers which can be read from (or in some cases written to). Registers of various kinds are combined into status groups and the status groups are nested: the output bits of a status group are summarized by a logical-OR gate. The summary output becomes one of several inputs to another status group. The various groups and registers are described in detail below.

SCPI terminology is not consistent. The distinction between a register and a group of registers is often ignored. Some status groups are called status registers. This manual does not attempt to correct SCPI's choice of words, but confusions of this kind will be pointed out where they occur.

3.3.2 Registers, Bit Numbers and Decimal Weights

When a register is read, its bit settings are converted into a single decimal number for transmission over the interface. The decimal weights for the various bits are shown below:

Bit:	7	6	5	4	3	2	1	0
Weight:	128	64	32	16	8	4	2	1

If Bit 0 (the least significant bit) is ON, its weight is 1. If Bit 7 (the most significant bit) is ON, its weight is 128. If 0 and 7 were the only bits ON, the register would have a decimal value of 129 (the sum of the weights). If all bits were ON, the register would have a decimal value of 255.

***NOTE:** Although SCPI defines some registers as having 16 bits, Giga-tronics makes use of only the lowest 8 bits of any register. Therefore, every register can be treated as if it contained only 8 bits.*

To determine which bits are on from the decimal value, find the largest weight that does not exceed the decimal value. Subtract that weight from the value and mark that bit ON. Continue subtracting weights, and marking the associated bits ON until the decimal value is reduced to zero.

EXAMPLE: The decimal value is 235.

Subtract 128 and mark Bit 7 ON. The decimal value is now 107.
Subtract 64 and mark Bit 6 ON. The decimal value is now 43.
Subtract 32 and mark Bit 5 ON. The decimal value is now 11.
Subtract 8 and mark Bit 3 ON. The decimal value is now 3.
Subtract 2 and mark Bit 1 ON. The decimal value is now 1.
Subtract 1 and mark Bit 0 ON. The decimal value is now 0.
Conclusion: Bits 7, 6, 5, 3, 1, and 0 are ON. Bits 4 and 2 are OFF.

This procedure is done in reverse in order to convert bit settings to a decimal value. Add together the decimal weights for each bit which is ON to find the equivalent decimal value.

EXAMPLE: Bits 6, 2, and 0 are ON.

Add the decimal weights (64 + 4 + 1) that are associated with those bits.
The decimal value is 69.

3.3.3 Status Group (Generalized Status Register Model)

Figure 3-1 shows how registers are typically combined to form a status group. The group consists of a condition register, a transition filter, an event register, and an enable register. (However, some status groups do not use the condition register or the transition filter.)

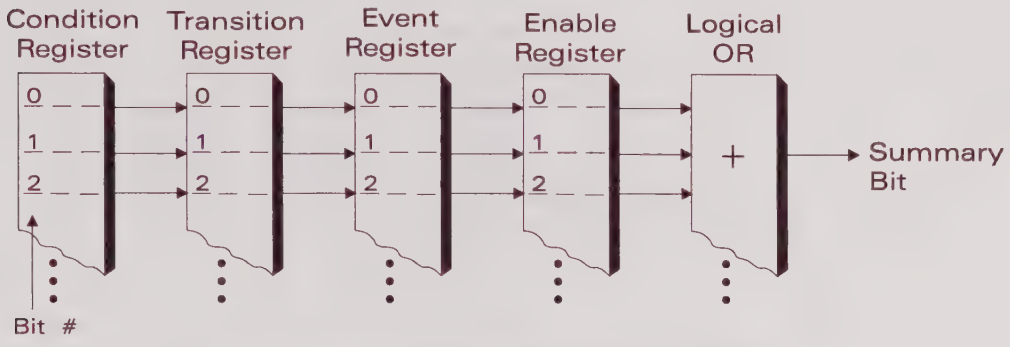

Figure 3-1: Generalized Status Register Group

The condition register continuously monitors the hardware and firmware status of the instrument. There is no latching or buffering for this register. It is updated in real time. The condition register is read-only. A 1 (ON) bit indicates an abnormal state.

The transition filter specifies which types of bit state changes in the condition register will set corresponding bits in the event register. Transition filter bits can be set for positive (0 to 1), negative (1 to 0), or both. Transition filters are read-write and are unaffected by *CLS or queries. They are set to all bits both at power on and after *RST.

The event register latches transition events from the condition register as specified by the transition filter. Bits in the event register are latched and once set, they remain set until cleared by a query or *CLS (clear status). There is no buffering, so while an event bit is set, subsequent events corresponding to that event are ignored. Event registers are read-only.

The enable register specifies which bits in the event register can generate a summary bit. A 1 bit in the same position in both the enable and event registers will cause a summary bit to be set. Summary bits are, in turn, recorded in another status group. Enable registers are read-write. Enable registers are not affected by *CLS (clear status). Querying enable registers does not affect them.

The processor in the Controller module is monopolized by the VXI Zero Slot Controller much of the time. It can process changes in condition registers only when the Series 12000A is executing a command addressed to it. When the processor receives a command, it compares the states of the condition registers at that time to their states as recorded when the last command was received and applies the transition filter to these state changes. To capture changes more frequently, send Read Status Byte queries (*STB?) periodically.

3.3.4 Status Byte Register

Figure 3-2 illustrates the status byte register (which is actually a status group, with no condition register or transition filter):

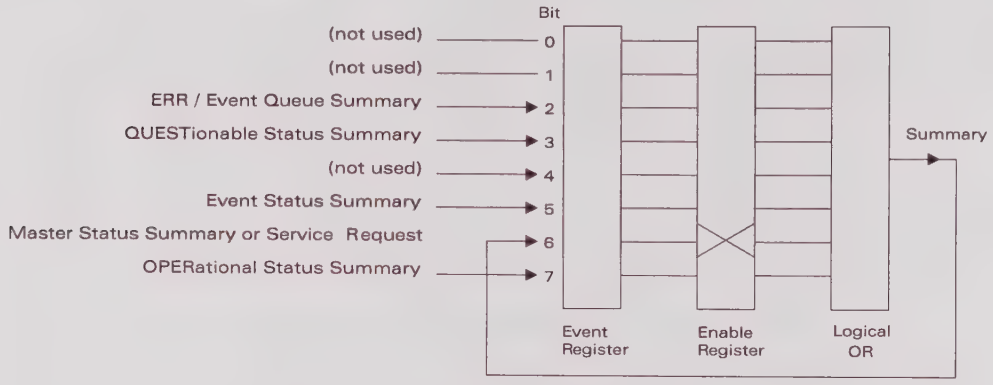

Figure 3-2: Status Byte Register

The individual bits are defined as follows:

Bit 2 (Err/Event Queue Summary)

This bit goes high to indicate that an error message has been stored in the Error/Event Queue.

Bit 3 (QUEStionable Status Summary)

This is the summary bit from the QUEStionable Status Group.

Bit 5 (Event Status Summary)

This is the summary bit from the Standard Event Status Group.

Bit 6 (Master Status Summary, or Service Request)

This is feedback from the summary bit of the Status Byte group itself. Because this is the final or most summarized status group, its summary bit is not furnished to a higher register. Instead, the summary bit is returned to Bit 6 of the Event Register. It is blocked at the Enable Register from affecting the OR-gate summary. The condition of the summary bit must be determined by reading the Status Byte Register and determining whether or not Bit 6 is on (alternatively, the system can be set up so that a Service Request interrupt is issued to the controller whenever the summary bit goes high).

Bit 7 (OPERational Status Summary)

This is the summary bit from the OPERational Status Group. The applicable 488.2 Common Commands are:

*SRE Service Request Enable command
*SRE? Service Request Enable query
*STB? Read Status Byte query

If all service requests are disabled with the command *SRE 0, then the query *SRE? will produce the reply 0. If the Status Byte register had only the Event Status summary bit ON, then the query *STB? would return 32 (because that is the decimal weight of bit 5 alone). If the command *SRE 32 is now sent to enable service requests for the Event Status summary bit, the query *SRE? will confirm by replying 32. The query *STB? would now return 96 because both the Event Status summary bit (weight

32) and the Require Service bit (weight 64) are ON. The Status Byte register is not cleared after it is queried. The primary causes of the bit settings must change in order for the bits to change.

3.3.5 OPERational Status Group

The diagram below illustrates the OPERational Status Group.

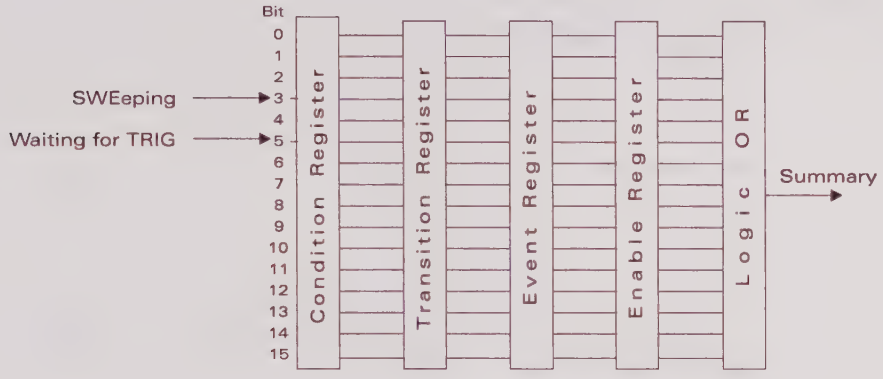

Figure 3-3: OPERational Status Group

Only two of this status group's bits are actually used:

Bit 3 (SWEeping)

This bit goes high when the synthesizer is performing a frequency sweep.

Bit 5 (Waiting for TRIG)

This bit goes high when the synthesizer is in the frequency sweep mode and is awaiting a hardware trigger input.

3.3.6 Standard Event Status Register

This is actually a status group as illustrated below. It includes the event and enable registers but not the condition register or the transition filter:

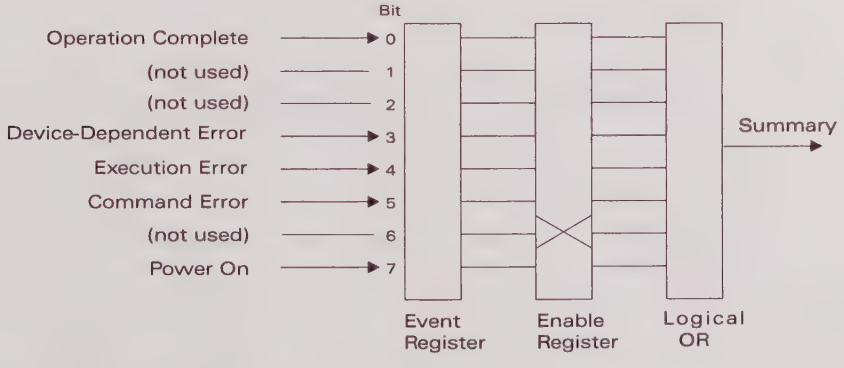

Figure 3-4: Standard Event Status Register

Individual bits of this register are defined as follows:

Bit 7 (Power On)

This event bit indicates that an off-to-on transition has occurred in the device's power supply.

Bit 5 (Command Error)

The parser detected a syntax or semantic error. This is usually caused by an unrecognized header or attempted query of a command-only header.

Bit 4 (Execution Error)

Probably an input data value was out of range or some device condition prevented an otherwise valid command from being executed.

Bit 3 (Device Dependent Error)

The device detected an error which was not one of those already described.

Bit 0 (Operation Complete)

This event bit is generated in response to the *OPC command. It indicates that the device has completed all selected pending operations. (Note that this bit is NOT set as a response to the query form of the command, *OPC?).

The applicable 488.2 Common commands are:

*ESE	Standard Event Status Enable command
*ESE?	Standard Event Status Enable query
*ESR?	Standard Event Status Register query

Reading the Standard Event Status Register with the *ESR? query also clears the register as does power up or the *CLS command.

3.3.7 QUEStionable Status Group

Figure 3-5 shows the entire status group in detail. The raw condition bits for STATus:QUEStionable:POWer and STATus:QUEStionable:FREQuency go through the transition filter to become event bits. These then match their counterparts in the enable register to contribute to the logical OR for the summary bit. The summary bit then becomes a raw bit in the condition register of the next higher level: the STATus:QUEStionable group.

The STATus:QUEStionable:POWer group uses a single bit to represent the leveled/unleveled status of the synthesizer's level control circuit (a 1 or ON bit indicates the unleveled state).

As shown in Figure 3-5, the STATus:QUEStionable:FREQuency group uses five bits to represent the locked/unlocked status of five different phase lock loops (a 1 or ON bit indicates an unlocked loop). To query the event register of the STATus:QUEStionable:FREQuency group, use the command line STATus:QUEStionable:FREQuency:EVENt? On receiving the decimal number reply, refer to Registers, Bit Numbers, and Decimal Weights (Section 3.3.2) to determine which bits are ON.

Remember that you must query an event register or issue the general *CLS command to zero the event register's ON bits.

3.3.8 Overview of the SCPI Status System

Figure 3-5 provides an overview of the entire status system. You can customize the status reporting (so that only certain conditions of interest are reported) by writing to the enable registers. The broadest stroke would result from the Status Byte Enable Register using the command *SRE. Then only the conditions which set bit 6 (the Master Summary, or Request Service) bit can be seen, using either the *STB? command or a service request mechanism.

The event status enable command *ESE performs the same function for that register. Enable registers within a status group can be set using, for example, STATus:QUEStionable:ENABle.

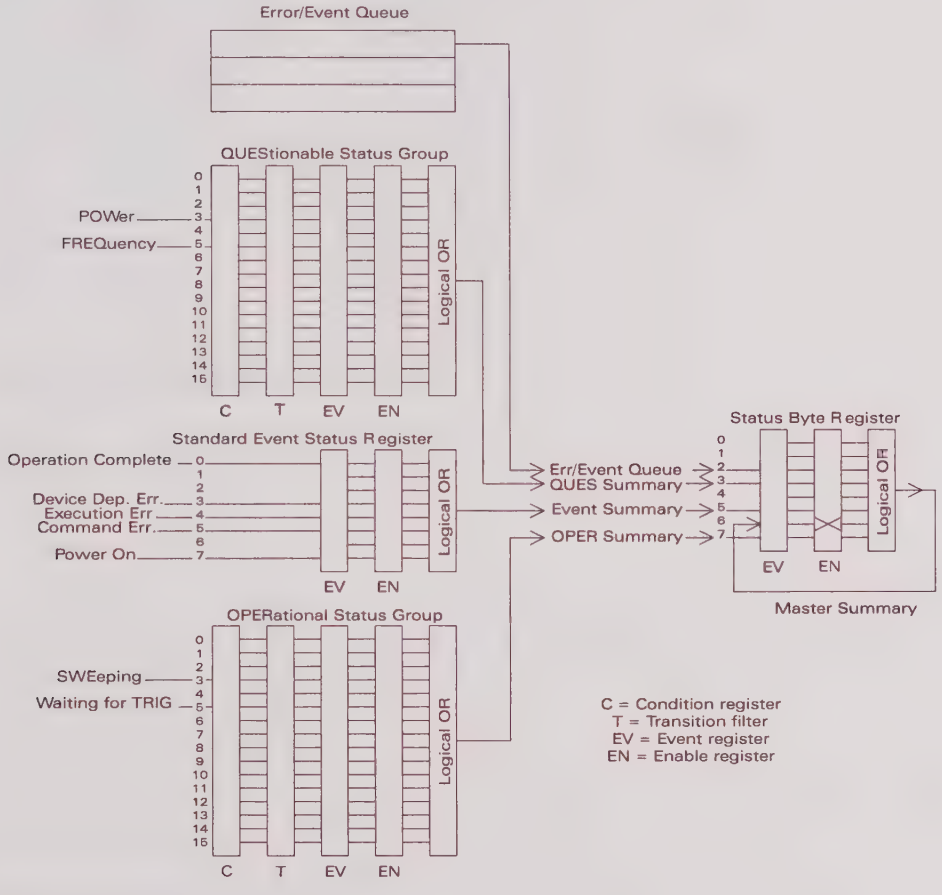

Figure 3-5: Overview of the SCPI Status System

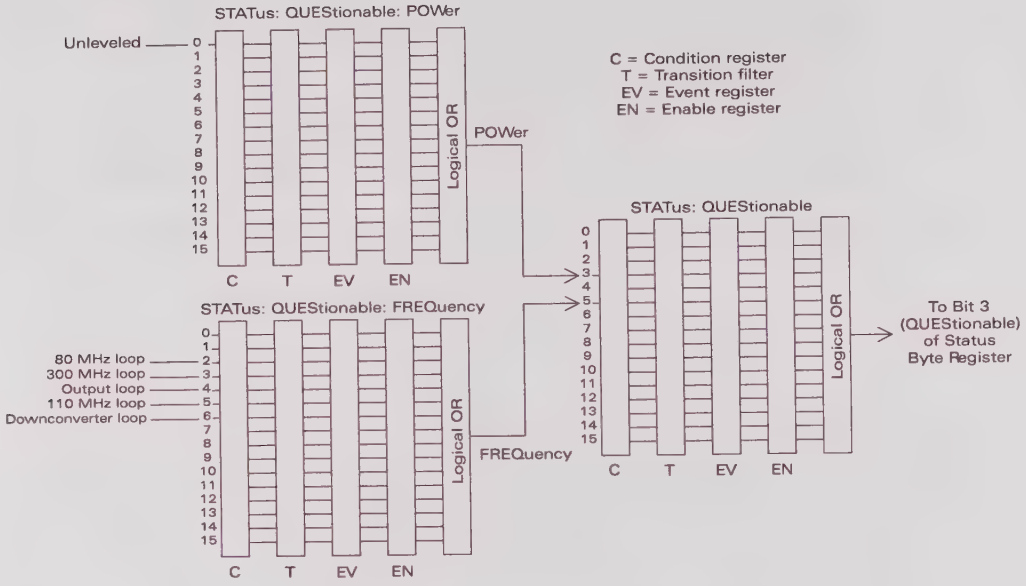

Figure 3-6: Detail of Error Monitoring System

3.4 Native Command Codes

3.4.1 IEEE 488 Interface

The Series 12000A permits data bus control in accordance with the IEEE Standard Digital Interface for Programmable Instruments, IEEE STD 488.2. Table 3-3 shows the IEEE 488 standard subsets that are implemented in the 12000A.

Table 3-3: Implemented IEEE 488 Subsets

Subset	Title	12000A Implementation
SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T8	Talker	Basic Talker
TEO	Extended Talker	No Capability
L4	Listener	Basic Listener
LEO	Extended Listener	No Capability
SRO	Service Request	No Capability
RL2	Remote/Local	Complete Capability
PPO	Parallel Poll	No Capability
DCO	Device Clear	No Capability
DTO	Device Trigger	No Capability
CO	Controller	No Capability

3.4.2 Command Syntax

The elements of the Series 12000A Native Interface Commands Codes are described in this section. Because some commands are included only for compatibility with earlier models, there are some variations in syntax from one command to another which must be carefully observed.

Function Codes

A native interface command includes a function code to indicate the nature and purpose of the command. Some commands contain a function code and nothing else. Commands consisting only of a function code are referred to in this manual as *simple* commands. However, most commands consist of a function code combined with other elements.

Address Assignment

The remote control address is assigned from the front panel of the instrument. The available range of addresses is 0 through 30.

Command Interpretation

The instrument uses a 40-character buffer to accept and store characters sent to it through the interface. Spaces are ignored. The buffer contents are interpreted and the buffer is reset upon receipt of a character sent with the EOI line asserted or upon receipt of any of the following delimiter characters:

```
> > , : ; / \
```

Multiple commands can be sent in a single message if they are separated from each other by a space or one of the delimiter characters. Each command will be interpreted individually upon receipt. If spaces are used to separate commands, care must be taken to assure that the 40-character buffer does not overflow. Buffer overflow can cause some commands to be ignored.

The 12000A can accept commands from a remote controller over the IEEE 488 interface or the RS-232 Serial port.

The 12000A syntax is designed to make the 12000A a compatible substitute for the HP 8340 in most remote-control operations. However, differences between the 12000A and the 8340 require some alteration of the 8340 command set; new commands are added, some existing commands differ slightly from their usual function when they are applied to the 12000A, and some existing commands are unsupported.

Commands in the 12000A syntax are represented in this manual by upper case letters. Some commands are followed by one or more lower case letters. These letters are interpreted as follows:

a Indicates that alphanumeric characters are expected.

b Indicates that one or more 8-bit bytes (entered in binary form) are expected.

d Indicates that a decimal number is expected. Decimal numbers can be signed. Exponents may be indicated by an E; thus, +4.5E-6 represents 4.5×10^{-6}.

h Indicates that a hexadecimal number is expected.

n Indicates that a single digit (0-9) is expected.

Terminator codes of HZ (Hz), KZ (kHz), MZ (MHz), GZ (GHz), DB (dB), DM (dBm), S (seconds), MS (ms), and US (μs) are used for many commands. Alternately, a comma or line feed can be used as a terminator; this causes the instrument to scale the corresponding function to the fundamental units of Hz, dB, dBm, or seconds.

The absence of lower case letters in a command indicates that the command is complete as shown, and requires no variables.

Commands with variables may be sent with either a space preceding the variable and/or terminator or with no space. For example: CW 12GZ, CW 12 GZ, CW12GZ, and CW12 GZ are all valid strings. If a command has multiple variables, they must be separated by a space.

A detailed description of many of the instrument functions may be found in Chapter 2 - Front Panel Operation.

3.4.3 Native Command Code Set

Table 3-4 lists the IEEE 488.2 native commands that are implemented in the Series 12000A. Most of these codes do not stand alone; commands; prefixes, variables, and suffixes must be combined with them. For further information refer to the sections cited in Table 3-4.

Table 3-4: 12000A Native Command Set

Command	Description	See Section
	Required Commands	
*CLS	Clear status byte	
*ESE n	Set Event Status Enable Register	
*ESE?	Ask for current status of Event Status Enable Register	
*ESR?	Ask for and clear Event Status Register bits	
*IDN?	Ask for instrument ID	
*OPC	Operation complete command	3.4.4
*OPC?	Operation complete query	
*RST	Software reset	
*SRE n	Set the service request mask (NOT SUPPORTED)	
*SRE?	Ask for service request mask (NOT SUPPORTED)	
*STB?	Ask for status byte	
/GTL	Go To Local for serial port	
/NATive	Native language, from anywhere	
/LLO	Local Lockout, for serial port	3.4.4
/SCPI	SCPI language, from anywhere	
	12000A Native Commands	
A n	Set ALC Mode	3.4.17
AD d	Set AM depth	3.4.3
AK n	Activate/deactivate marker amplitude	3.4.10
AM n	Activate/deactivate amplitude modulation	3.4.13
AMF n	Activate/deactivate amplitude modulation	3.4.13
AR d	Set internal AM rate (HZ,KZ,MZ,GZ)	3.4.13
AT d	ALC Set attenuator (DB)	3.4.17
AU	Set sweep time to shortest	3.4.9
CF d	Set CENTER Parameter (HZ,KZ,MZ,GZ)	3.4.9
CS	Clear Status	3.4.18
CW d	Set CW frequency (HZ,KZ,MZ,GZ)	3.4.5
CW	Set GPIB active parameter	3.4.5
D1	Set repeat mode for step freq sweep to Continuous	3.4.8
D2	Set repeat mode for step freq sweep to Single-Sweep	3.4.8
D4	Set repeat mode for step freq sweep to Single-Step	3.4.8
DF d	Set SPAN parameter (HZ,KZ,MZ,GZ)	3.4.9
DN	Handle pressing step DOWN key	3.4.18
DU n	Specify GPIB screen	3.4.18
EF	Lock knob	3.4.18
EK	Unlock knob	3.4.18
ERR?	Error de-queue (use SCPI mechanism)	TBA
FA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.4.9
FA	Set active parameter to start frequency	3.4.9

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	See Section
FB d	Set Stop parameter (HZ,KZ,MZ,GZ)	3.4.9
FB	Set active parameter to stop frequency	3.4.9
FC d	Set Sweep time (S,MS,US)	3.4.9
FC	Set active parameter to sweep time	3.4.9
FD d	Set FM deviation (HZ,KZ,MZ,GZ)	3.4.14
FM n	Activate/deactivate FM	3.4.14
FR d	Set internal FM rate (HZ,KZ,MZ,GZ)	3.4.14
FT n	Set FM mode	3.4.14
GA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.4.8
GA	Set active parameter to start frequency	3.4.8
GB d	Set Stop frequency (HZ,KZ,MZ,GZ)	3.4.8
GB	Set active parameter to stop frequency	3.4.8
GC d	Set Step size (HZ,KZ,MZ,GZ)	3.4.8
GC	Set active parameter to step size	3.4.8
GD d	Set Dwell time (S,MS,US)	3.4.8
GD	Set active parameter to dwell time	3.4.8
GT6100	Switch to 6100 Command Set (Not Implemented)	
IF	Increment CW frequency by minimum step size	3.4.5
IH	Initialize heap space to empty	3.4.18
IP	Instrument preset	3.4.18
L1	Set Repeat mode for list freq sweep to Continuous	3.4.6
L2	Set Repeat mode for list freq sweep to Single-Sweep	3.4.6
L4	Set Repeat mode for list freq sweep to Single-Step	3.4.6
LA n n	Add list point	3.4.6
LC n	Delete list	3.4.6
LD n n	Delete list point	3.4.6
LF n n d	Set frequency d of point n2 of list n1 (HZ,KZ,MZ,GZ)	3.4.6
LGA d	Set list point frequency (HZ,KZ,MZ,GZ)	3.4.6
LGB d	Set list range stop frequency (HZ,KZ,MZ,GZ)	3.4.6
LGC d	Set list range step size (HZ,KZ,MZ,GZ)	3.4.6
LGD d	Set list range dwell (HZ,KZ,MZ,GZ)	3.4.6
LGI n	Insert range as list number	3.4.6
LGL d	Set list range power output (DM)	3.4.6
LL n n d	Set list point power (DM)	3.4.6
LMA n n n	Set list point AM status	3.4.6
LMF n n n	Set list point FM status	3.4.6
LMP n n n	Set list point PM status	3.4.6
LR n	Run list	3.4.6
LS? n	Precompute list	3.4.6
LT n n d	Set list point dwell (S,MS,US)	3.4.6
M n d	Set marker frequency (HZ,KZ,MZ,GZ)	3.4.10
M0	Turn off last active marker	3.4.10
MC	Move last active marker to center sweep	3.4.10
MO	Turn off last active marker	3.4.10

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	See Section
NM	Cycle through FM modes	3.4.14
NSR	Never say remote - diagnostic command	3.4.18
OA	Output active parameter value	3.4.16
OC	Output start, center, time parameter for freq sweep	3.4.16
OD	Output diagnostic characters	3.4.16
OGI	Make OI respond with Giga-tronics info	3.4.16
OI	Output identification	3.4.16
OPAS	Output lock and level flag	3.4.16
OPCF	Output center frequency parameter value	3.4.16
OPCW	Output CW frequency value	3.4.16
OPDF	Output data frequency parameter value (span)	3.4.16
OPFA	Output start frequency parameter value	3.4.16
OPFB	Output stop frequency parameter value	3.4.16
OPM n	Output Marker frequency value	3.4.16
OPPL	Output CW level value	3.4.16
OPSF	Output CW frequency step value	3.4.16
OR	Output CW level value	3.4.16
OS	Output Lock and Level value in binary	TBA
P1	Set Repeat parameter for ramp power sweep to Continuous	3.4.12
P2	Set Repeat parameter for ramp power sweep to Single-Sweep	3.4.12
P3	Set Repeat parameter for ramp power sweep to stop	3.4.12
PA d	Set Start parameter (DM)	3.4.12
PB d	Set Stop Parameter (DM)	3.4.12
PC d	Set sweep time	3.4.12
PH2	Lock Hi-power module on	3.4.18
PI	Select Pulse Interval	3.4.15
PL d	Set CW power level	3.4.5
PL d	Set GPIB active parameter (DM)	3.4.5
PM n	Activate/deactivate pulse modulation	3.4.15
PR d	Set internal PM rate (HZ,KZ,MZ,GZ)	3.4.15
PS n	Activate/deactivate power sweep	3.4.12
PW d	Set internal PM width (S,MS,US)	3.4.15
PWV n	Select Pulse waveform	3.4.15
PY d	Set internal PM delay (S,MS,US)	3.4.15
QA d	Set Start parameter (DM)	3.4.11
QB d	Set Stop parameter (DM)	3.4.11
QC d	Set Step parameter (DB)	3.4.11
QD d	Set Dwell parameter (S,MS,US)	3.4.11
RC n	Recall setup	3.4.18
RF n	Turn RF off or on	3.4.5
RFD n	RF on/off @ frequency change	3.4.18
RS	Re-start sweep	Multiple
S1	Set Repeat parameter for ramp freq sweep to Continuous	3.4.9
S2	Set Repeat parameter for ramp freq sweep to Single-Sweep	3.4.9

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	See Section
S3	Set Repeat parameter for ramp freq sweep to stop	3.4.9
SC n	Activate/deactivate Scan modulation	3.4.13
SCPI	Switch to SCPI language	
SD d	Set depth for Scan modulation or variable attenuation (DB)	3.4.13
SF d	Set CW frequency resolution	3.4.5
SG	Set Repeat parameter Single-sweep	3.4.9
SHA1	Select unleveled mode (disable ALC)	3.4.17
SHCW d	Set CW frequency step size (HZ,KZ,MZ,GZ)	3.4.5
SHM4 d	Run self-test program (HZ,KZ,MZ,GZ)	3.4.18
SHPL d	Set CW power step size (DB)	3.4.5
SHPM	Activate external PM for Model 8757A	3.4.15
SHPS d	Uncouple and set attenuator	3.4.17
SHRF	Select unleveled mode (disable ALC)	3.4.17
SHRL	Re-Couple Attenuator	3.4.17
SHS n	Display blanked	3.4.18
SHSL d	Uncouple and set attenuator	3.4.17
SM	Stop sweep and permit incremental adjustment	3.4.8
SN d	Set Step count parameter	3.4.8
SP d	Set CW power resolution	3.4.5
SR d	Set rate for scan modulation (HZ,KZ,MZ,GZ)	
ST d	Set ramp power and frequency sweep time (S,MS,US)	3.4.9
ST	Set GPIB active parameter	3.4.9
SV n	Store setup	3.4.18
TR n	Set sweep trigger	Multiple
TS	Set sweep parameter to Single Sweep	3.4.9
UO t	Update flash parameter block	TBA
UP	Handle pressing step UP key	

3.4.4 IEEE Common Commands

- **ERR?**
- ***IDN?**
- ***RST**

These commands perform functions as defined in the IEEE 488.2 standard.

ERR?

Syntax: ERR?

Response: Returns the error number and a description of the error: e.g., 107,"Frequency above maximum; maximum frequency is 20.1 GHz" (e.g. following a CW40GZ command)

Description: This command reports the next entry in the instrument's error queue. There may be up to 20 messages in the queue; the messages are reported out oldest first. The error report consists of an error number followed by a description of the error. If the error queue is empty, the error report is **0, No error**. If the queue fills up, the last (newest) error report is replaced with **350, Queue overflow**.

*IDN?

Syntax: *IDN?

Description: The instrument identification string can be requested with this command. The following string will be returned: Giga-tronics, model number, serial number, version and build number, such as Giga-tronics, 12520A, 992604, 1.05-44.5

*RST

Syntax: *RST

Description: This command will cause the instrument to reset. The reset conditions are:

Frequency:	Minimum
Level:	0 dBm
ALC:	Internal
Atten:	Automatic
Modulation:	All Off
AM:	Ext @ 90%
FM:	Ext @ 2 KHz
Pulse:	Ext + True

3.4.5 Fixed Frequency/Level Commands

- CW
- IF
- PL
- RF
- SF
- SHCW
- SHPL
- SP

These commands set or control parameters to operate the instrument in fixed frequency and/or fixed output level modes.

CW

Syntax: CW *d* [HZ | KZ | MZ | GZ]

Example: CW 12 GZ ! Set the frequency to 12 GHz
! CW Puts the instrument into CW mode

Description: This command puts the instrument into CW mode and sets the CW frequency to *d* [HZ | KZ | MZ | GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units in which *d* is expressed. No terminator implies Hz. Note that if the CW command is sent with no variable the instrument will return to CW mode at the last frequency entered.

IF

Syntax: IF

Description: This command will increment the CW frequency by the minimum resolvable step. This is normally 0.1 Hz, unless Option 36 (1 kHz resolution) is present.

PL

Syntax: PL *d* DM

Example: PL -6.2 DM ! Set power to -6.2 dBm

Description: This command sets the CW power to *d* dBm. The CW power is used during CW mode, step frequency sweep and ramp frequency sweep.

RF

Syntax: RF n

Example: RF 1 ! Turns RF on

Description: This command controls the RF output of the instrument. Sending RF 1 turns on the RF; sending RF 0 turns off the RF.

SF

Syntax: SF *d terminator*

Example: SF 50 MZ ! Set frequency resolution to 50 MHz

Description: This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ | KZ | MZ | GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units *d* is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.

SP

Syntax: SP *d terminator*

Example: SP 5 DB ! Set power resolution to 5 dB

Description: This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.

SHCW

Syntax: SHCW *d terminator*

Example: SHCW 50 MZ ! Set frequency resolution to 50 MHz

Description: This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ | KZ | MZ | GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units *d* is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons. This command is included for compatibility with Hewlett Packard (Agilent) scalar analyzers.

SHPL

Syntax: SHPL *d terminator*

Example: SHPL 5 DB ! Set power resolution to 5 dB

Description: This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.

3.4.6 List Mode Commands

- **L*n***
- **LA**
- **LC**
- **LD**
- **LF**
- **LGA**
- **LGB**
- **LGC**
- **LGD**
- **LGI**
- **LGL**
- **LL**
- **LMA**
- **LMF**
- **LMP**
- **LR**
- **LS?**
- **LT**
- **TR**

These commands control the operation of the instrument is the List Mode. List Mode is specifically designed to provide the fastest frequency and level switching speeds. Each list is a set of frequencies in any arbitrary order. Power level, dwell and modulation parameters may be set for each frequency. Refer to section 3.4.7 for additional details.

L1

Syntax: L1

Description: This command causes the List Mode to run continuously once the LR command has been issued. Continuous repeat mode supports Immediate, Trigger in BNC, and Softkey triggers (see TR commands).

L2

Syntax: L2

Description: This command causes the List Mode to run once before stopping after the LR command has been issued. When the list is exhausted, the frequency remains at the frequency of the last point. Single Sweep mode supports Immediate, Trigger in BNC, and Softkey triggers (see TR commands).

L4

Syntax: L4

Description: This command causes the List Mode to take a single step-to the next list point-in response to a trigger once the LR command has been issued. The first trigger sets the frequency to the first point in the list being run. Subsequent triggers advance the frequency to the next list point. When the last point in the list is reached, the next trigger returns the frequency to the first point in the list. Single Step mode supports Trigger in BNC and Softkey triggers (see TR commands).

LA

Syntax: LA *n1 n2*

Example: LA 2 6 ! Adds a point to list 2 after point number 6

Description: Adds a point to list *n1* after point number *n2*.

n2 = 1 is the first list

n2 = 1 is the first point in the list. Set n2 = 0 to insert a point at the head of the list. The frequency, power, dwell and modulation status of the added point are set to: a) the same values as the point it is inserted after, or b)

if n2 = 0, to the same values as the point it is inserted before, or c) if the list is empty, to the instrument's minimum frequency, 0.00 dBm, 100 ms, modulation off.

Note that the LA command only establishes the point. It is then necessary to send the LF, LL, LT and LMx commands to set any parameters which need to be changed.

LC

Syntax: LC *n*

Example: LC 1 ! Clears List number 1

Description: The LC command will clear all the points from the selected list

LD

Syntax: LD *n1 n2*

Example: LD 2 6 ! Delete point 6 from List number 2

Description: Deletes point n2 from list n1. n2 = 1 denotes the first point in the list; n1 = 1 denotes the first list. After a point is deleted, the following points in the list are promoted to replace the one deleted.

LF

Syntax: LF *n n d* [HZ | KZ | MZ | GZ]

Example: LF 2 6 5 GZ ! Set point 6 in List 2 to 5 GHz

Description: Sets the frequency for point n2 of list n1 to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz.

The LGA through LGL list range commands allow automatic generation of a list of frequencies starting at a given point, with a fixed increment, and ending at a given point. This effectively creates a digital (step) sweep, but permits flexible editing techniques of the list mode. A common dwell and level may be set for the range

LGA

Syntax: LGA *d* (HZ|KZ|MZ|GZ)

Example: LGA 2 GZ ! Set list range start to 2 GHz

Description: The start frequency for the list range is set with this command.

LGB

Syntax: LGB *d* (HZ|KZ|MZ|GZ)

Example: LGB 12 GZ ! Set list range stop to 12 GHz

Description: The stop frequency for the list range is set with this command.

LGC

Syntax: LGC *d* (HZ|KZ|MZ|GZ)

Example: LGC 1 MZ ! Set list range step size to 1 MHz

Description: The step size for the list range is set with this command.

LGD

Syntax: LGD *d* (S|MS|S)

Example: LGD 25 MS ! Set list range dwell to 25 mS

Description: The dwell time for each point in the list range is set with this command.

LGI

Syntax: LGI *n*

Example: LGI 1 ! Insert the range as list #1

Description: This command inserts the list range as the given list number. Note that it takes about 10 mS per step to generate the list. Sufficient time must be given in the program for this task to complete.

LGL

Syntax: LGL *d* DM

Example: LGL -3 DM ! Set list range power to -3 dBm

Description: The power output for each point of the list range is set with this command.

LL

Syntax: LL *n1 n2 d* DM

Example: LL 2 6 -3.5 DM ! Set point 6 in List 2 to -3.5 dBm

Description: Sets the power level for point n2 of list n1 to *d* DM, where *d* is the power level (a decimal number with possible decimal point and/or exponent) in dBm.

LMA

Syntax: LMA *n n n*

Example: LMA 1 3 1 ! Set AM ON for list #1, point #3

Description: This command sets the status of Amplitude Modulation for various points in a list. There are three variables: The first indicates the list number; the second defines the point within the list; the third is 1 to turn AM on or 0 to turn AM off. All list points default to AM OFF when they are added.

LMF

Syntax: LMF *n n n*

Example: LMF 1 3 1 ! Set FM ON for list #1, point #3

Description: This command sets the status of Frequency Modulation for various points in a list. There are three variables: The first indicates the list number; the second defines the point within the list; the third is 1 to turn FM on or 0 to turn FM off. All list points default to FM OFF when they are added.

LMP

Syntax: LMP *n n n*

Example: LMP 1 3 1 ! Set PM ON for list #1, point #3

Description: This command sets the status of Pulse Modulation for various points in a list. There are three variables: The first indicates the list number; the second defines the point within the list; the third is 1 to turn PM on or 0 to turn PM off. All list points default to PM OFF when they are added.

LR

Syntax: LR *n*

Example: LR 2 ! Start List number 2 running

Description: Starts List Mode running list *n*. The type of list (e.g. Continuous, Single Sweep, or Single Step) is determined by what L( ) command has been sent. Note that the status of the TR( ) command will determine if the List starts immediately or is triggered. To stop List Mode, send the CW command

LS?

Syntax: LS? *n*

Example: LS? 2 ! Set up List number 2

Description: Does the calculations for list *n*, and stores the calculated values in RAM. Returns 0 when done. When the pre-calculated list is subsequently run, the first trace will run at full speed, since the instrument will not need to do the calculations as part of executing the first trace. Allow about 25 mS per point for this command.

LT

Syntax: LT *n1 n2 d* [S | MS | US]

Example: LT 2 6 20 MS ! Set the dwell for List 2, point 6 to 20 ms

Description: Sets the dwell time for point n2 of list n1 to *d* [S | MS | US], where *d* is the dwell time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] are the units for the dwell time. S is seconds, MS is milliseconds, and US is microseconds. No terminator implies seconds.

TR

Syntax: TR *n*

Example: TR 2 ! Sets the current list trigger to immediate

Description: Sets the trigger condition for the current list as specified by the value *n*:

n = 0: Sets the trigger condition for the current list to **Trigger In BNC**. This will stop the current list at its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 1: Sets the trigger condition for the current list to *Softkey or GPIB*. Setting this trigger type stops the current list until the soft key is pressed or the GPIB GET is received, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 2: Sets the trigger to **Immediate** - i.e., no trigger condition; the list will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep or a single-step list mode.

3.4.7 Manipulating Lists via GPIB

3.4.7.1 Controlling List Execution

List execution is governed by the "LR n", "TR n", and "Ln" commands:

- The TR n command specifies the conditions that begin, or trigger, list execution. Valid values of 'n', and their meanings, are:
    - 0 – trigger from the external trigger input
    - 1 – trigger from a GPIB GET event or from the front panel's List menu's trigger softkey
    - 2 – trigger immediately
- The Ln command specifies the conditions that stop list execution. Valid values of 'n', and their meanings, are:
    - 0 - Continuous: Execute the entire current list, repeating it indefinitely.
    - 2 - Single Sweep: Execute the entire current list, and then stop; the next trigger will resume execution at the start of the list.
    - 4 - Single Step: Execute the current list point, and then stop; the next trigger will resume execution with the next list point. The list's first point is considered to be the initial current point, and is also considered to be the point following the list's final point.
- The LR n command simply designates which list is the current list, i.e. is to be executed; it does not itself automatically cause list execution to commence, unless of course the most recent Ln command was L0.

3.4.7.2 Speeding Up List Entry

The manipulation (adding, editing, deleting) of large numbers of list points can be speeded up by changing the list trigger mode from the default mode (immediate) to a non-immediate one, e.g.:

- TR 0

This will relieve the 12000A's firmware of the burden of repeatedly terminating and relaunching list execution in response to each command's arrival, leaving it free to devote itself entirely to command processing. After the list points are manipulated, and their lists precompiled, the trigger mode can be changed as desired.

3.4.7.3 Precompilation of Lists

In the 12000A, list points exist in two different forms. One is the *source* form, where the data describing a point is in a form that closely corresponds to the human readable formats used by the front panel's list menu and the GPIB Lxxx commands. Source form points are *compiled* to create corresponding *object* form points, which are in a format that is understandable to the 12000A's actual signal generation hardware. Normally, compilation is performed during list execution; while point N of a list is being output by the hardware, point N+1 is being compiled by the firmware. The process is invisible to the user, as long as the dwell times of list points are longer than their compilation time (currently about 25 ms a piece). If point dwell times are lower than this value, list execution will be 'slow':

- At the end of a point's dwell time, list execution will pause until next point's compilation is completed.
- If Config | Retrace is set to RF Off, then RF will be blanked during this period.
- If List | Repeat Mode is set to Single Step, trigger events may be missed.

To enable real-time execution of lists with 'short' dwell times, the 12000A contains a feature known as *list precompilation*, which is implemented via the "LS? n" native mode GPIB command. The basic procedure is as follows, using list #3 as an example:

1. Add and/or edit the list's points, e.g.

   LA 3,0
   LF 3,1,1 GZ
   LL 3,1,0 DM
   LT 3,1,100 MS
   etc.

2. Issue "LS? 3"

3. Allow adequate time for the list to compile.

4. Read the command's response ("0", i.e. zero) from the GPIB bus.

The list may then be executed after first specifying it as the current list, via an LR 3 command.

Precompilation may need to be repeated whenever:

- Points are added to or removed from the list.
- Points are edited.
- The unit's AC line power is cycled

3.4.7.4 Multiple Precompiled Lists

The 12000A also supports the precompilation of multiple lists. This can be done by following the single list precompilation procedure for each list of interest; alternately:

1. Add and/or edit all the points for all the lists.
2. Issue an LS? command (and await and read the response therefrom) for each list.

Execution of multiple precompiled lists is somewhat more involved. Instead of simply issuing an LR n command for a given list, it is necessary to issue the LS? n / read bus / LR n sequence, e.g.:

1. Add/edit list #2's points.
2. Add/edit list #7's points.
3. Issue LS? 2 / wait / read bus.
4. Issue LS? 7 / wait / read bus.
5. Issue LR 7.
6. Execute list 7 via whatever triggering.
7. Issue LS? 2 / read bus / LR 2.
8. Execute list 2 via whatever triggering.
9. Issue LS? 7 / read bus / LR 7.
10. Execute list 7 via whatever triggering.

☛ ***NOTE:*** *In steps 7 and 9, no 'wait' was specified. This is because the LS? n command's execution is lengthy only when a list needs to be recompiled; if the list was previously compiled and does not require recompilation, the command will execute quickly.*

3.4.7.5 Storage of List Points

The 12000A allocates storage for list points from pools of memory; thus, the storage requirement for a given number of list points is largely independent of the number of lists in which they are placed. For example, a single list of 100 points requires about the same amount of storage as 10 lists of 10 points each.

Source form points are allocated from nonvolatile memory, so that they will be preserved across cyclings of the unit's AC line power, i.e. across *line power sessions*. This pool of memory is shared by unit setups that are saved via the front panel's System | Store button; nevertheless, there is sufficient space for several thousand points. Object form list points are allocated from volatile memory, i.e. they do not persist beyond the current line power session. Many aspects of the unit's functionality share this pool of memory; therefore, the allocation of an excessive number of object form list points may impair other aspects of the unit's behavior. Deletion of object form list points (see next page) may replenish this pool to a state suitable to these other aspects; however, only the cycling of line power is guaranteed to effect a complete replenishment. Currently, we recommend that the number of object form list points be limited to 1000.

The following lists of circumstances are given to help the user insure that the limit on object point quantities can be observed.

Events causing allocation of source form points include:

- The adding of a point (LA n command).

Events causing their deallocation include:

- The removal of a point (LD n1 n2 command).
- The deletion of an entire list (LC n command).
- Receipt of the IH or IP commands.
- Any other event that causes the clearing of nonvolatile memory.

Events causing allocation of object form points include:

- The editing of a source form point (LF, LL, LT, etc. commands).
- The precompilation of a list (LS? n command).
- The running of a list that is not precompiled (LR n command).

Events causing their deallocation include:

- The deletion of a source form list (LC n command).
- The cycling of line power.

☛ ***NOTE:*** *Lists, when edited or executed, consume object form points, regardless of whether they are precompiled. Also note that the only way to recycle object form points during a given line power session is to delete an entire source form list, via the LC n command.*

3.4.7.6 Precompiling Saved Lists

Currently, the 12000A exhibits a glitch in the precompilation and subsequent execution of lists that were input to the unit during a previous line power session (and thus automatically saved in nonvolatile memory). The workaround is as follows:

1. Create a single point list having a fairly long dwell time, and suitable power and frequency, e.g.:
   - LA 100,0
   - LT 100,1,10 S
2. Issue an LR n command for the list, e.g.:
   - LR 100
3. Change the list trigger mode to 'immediate', e.g.:
   - TR 2
   - L1
4. Wait a moment.
5. Change the list trigger mode to a non-immediate form, e.g.:
   - L2
   - TR 0

This workaround procedure should be executed prior to precompiling and subsequently executing the saved list(s) of interest.

3.4.8 Step Frequency Sweep Commands

The following commands control the operation of the instrument during Step Frequency Sweep. This mode of operation permits stepping the frequency between two points with a user defined step size and dwell time. Step Frequency Sweep provides discrete increments of frequency.

- **D*n***
- **GA**
- **GB**
- **GC**
- **GD**
- **RS**
- **SM**
- **SN**
- **TR**

D1

Syntax: D1

Description: Puts step frequency sweep into continuously sweeping mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, dwell) must have been previously set.

D2

Syntax: D2

Description: Puts step frequency sweep into single sweep mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, dwell) must have been previously set.

D4

Syntax: D4

Description: Puts step frequency sweep into single step mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, dwell) must have been previously set.

GA

Syntax: GA *d* [HZ | KZ | MZ | GZ]

Example: GA 5 GZ ! Set the step frequency start to 5 GHz

Description: Sets the start frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

If the GA command is sent with no variable it makes the step frequency sweep start frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep

GB

Syntax: GB *d* [HZ | KZ | MZ | GZ]

Example: GB 8 GZ ! Set the step frequency stop to 8 GHz

Description: Sets the stop frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

Note that if the GB command is sent with no variable it makes the step frequency sweep stop frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

GC

Syntax: GC *d* [HZ | KZ | MZ | GZ]

Example: GC 12.5 MZ ! Set the step frequency sweep step size to 12.5 MHz

Description: Sets the step size for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

Note that if the GC command is sent with no variable it makes the step frequency sweep step size the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

GD

Syntax: GD *d* [S | MS | US]

Example: GC 25 MS ! Set the step frequency dwell time to 25 ms

Description: Sets the dwell time for a step frequency sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies S. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

If the GD command is sent with no variable it makes the step frequency sweep dwell time the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.

RS

Syntax: RS

Description: This command restarts the current Sweep or List mode. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

SM

Syntax: SM

Description: The SM command is only meaningful if a sweep is in process. When received, the sweep is interrupted and manual control (knob, keypad, or up/down buttons) of the frequency or power (if a power sweep) is enabled. The sweep may be restarted using a softkey on the sweep menu.

SN

Syntax: SN *d*

Example: SN 20 ! Activate step frequency sweep, start/steps Mode, with 20 steps.

TR

Syntax: TR *n*

Example: TR 2 ! Sets the current sweep trigger to immediate

Description: Sets the trigger condition for the current sweep as specified by the value *n*:

n = 0: Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep at its current until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 1: Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 2: Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep or a single-step list mode.

3.4.9 Ramp Frequency Sweep Commands

The Ramp Frequency Sweep mode (also known as Analog Sweep) produces a linear change in frequency over a specified time period. The sweep is defined between two frequency points. Although the frequency is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

- **AU**
- **CF**
- **DF**
- **FA**
- **FB**
- **FC**
- **RS**
- **S*n***
- **SG**
- **ST**
- **TR**
- **TS**

AU

Syntax: AU

Description: This command automatically sets the sweep time to the shortest possible using the start and stop frequencies as the determining parameters. Since the instrument uses a frequency division scheme for frequencies below 4 GHz, the shortest allowable sweep times are a function of the division in use.

CF

Syntax: CF *d* [HZ | KZ | MZ | GZ]

Example: CF 4 GZ ! Activate Ramp Sweep with a 4 GHz Center frequency

Description: Sets the center for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the center frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep

DF

Syntax: DF *d* [HZ | KZ | MZ | GZ]

Example: DF 5 GZ ! Activate Ramp Sweep with a 5 GHz Delta sweep

Description: Sets the delta for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the delta frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep

FA

Syntax: FA *d* [HZ | KZ | MZ | GZ]

Example: FA 5 GZ ! Set the Ramp Frequency start to 5 GHz

Description: Sets the start frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

If the FA command is sent with no variable it makes the Ramp Frequency Sweep start frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep

FB

Syntax: FB *d* [HZ | KZ | MZ | GZ]

Example: FB 8 GZ ! Set the Ramp Frequency stop to 8 GHz

Description: Sets the stop frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

If the FB command is sent with no variable it makes the Ramp Frequency Sweep stop frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

FC

Syntax: FC *d* [S | MS | US]

Example: FC 25 MS ! Set the Ramp Frequency Sweep time to 25 ms

Description: Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

If the FC command is sent with no variable it makes the Ramp Frequency Sweep time the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

RS

Syntax: RS

Description: This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

S1

Syntax: S1

Description: Puts Ramp Frequency Sweep into continuously sweeping mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

S2

Syntax: S2

Description: Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

S3

Syntax: S3

Description: This command stops the Ramp Frequency Sweep. The frequency may now be adjusted manually.

SG

Syntax: SG

Description: Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

ST

Syntax: ST *d* [S | MS | US]

Example: ST 100 US ! Set the Ramp Sweep time to 100 ms

Description: Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

TR

Syntax: TR *n*

Example: TR 2 ! Set the current sweep trigger to immediate

Description: Sets the trigger condition for the current sweep as specified by the value *n*:

n = 0: Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 1: Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 2: Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

TS

Syntax: TS

Description: Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

3.4.10 Marker Commands

Markers are provided during frequency sweeps to allow identifying specific points along the sweep. This set of commands permits marker assignment and selection.

- **AK**
- **M0**
- **M( )**
- **MC**
- **MO**

AK

Syntax: AK *n*

Example: AK 1 ! Turn on the Amplitude Marker

Description: AK 1 activates and AK 0 deactivates a function which causes a 3 dB drop in the RF output power to occur at marker frequencies.

M0

Syntax: M0

Description: This command deactivates the marker that was last activated.

M( )

Syntax: M( ) *d* [HZ | KZ | MZ | GZ]d

Example: M5 7.2 GZ ! Activates marker 5 at 7.2 GHz

Description: Each of the eight available markers may individually be activated and set to a particular frequency using this command. To turn off a particular marker, first activate it using (e.g. M5) then send the M0 command.

MC

Syntax: MC

Description: Places the last activated marker at the sweep center frequency.

MO

Syntax: MO

Description: This command deactivates the marker that was last activated.

3.4.11 Step Power Sweep Commands

The following commands control the operation of the instrument during Step Power Sweep. This mode of operation permits stepping the power between two points with a user defined step size and dwell time. Step Power Sweep provides discrete increments of Power.

- **QA**
- **QB**
- **QC**
- **QD**
- **RS**
- **TR**

QA

Syntax: QA *d* DM

Example: QA 2 DM ! Set the Step Power Sweep start to 2 dBm

Description: Sets the start power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.

If the QA command is sent with no variable it makes the Step Power Sweep start power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep

QB

Syntax: QB *d* DM

Example: QB 8 DM ! Set the Step Power Sweep stop to 8 dBm

Description: Sets the stop power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.

If the QB command is sent with no variable it makes the Step Power Sweep stop power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep

QC

Syntax: QC *d* DM

Example: QC .1 DB ! Set the Step Power Sweep step to .1 dB

Description: Sets the step size for a Step Power Sweep to *d* [DB], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DB] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.

If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep

QD

Syntax: QD *d* [S | MS | US]

Example: QD 5 MS ! Set the Step Power Sweep dwell to 5 ms

Description: Sets the dwell time for a Step Power Sweep to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.

If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep

RS

Syntax: RS

Description: This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

TR

Syntax: TR *n*

Example: TR 2 ! Sets the current sweep trigger to immediate

Description: Sets the trigger condition for the current sweep as specified by the value *n*:

n = 0: Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 1: Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 2: Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.4.12 Ramp Power Sweep Commands

The Ramp Power Sweep mode (also known as Analog Power Sweep) produces a linear change in power over a specified time period. The sweep is defined between two power levels. Although the power is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

- **P*n***
- **PA**
- **PB**
- **PC**
- **PS**
- **RS**
- **TR**

P1

Syntax: P1

Description Puts Ramp Power Sweep into continuously sweeping mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

P2

Syntax: P2

Description: Puts Ramp Power Sweep into single sweep mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. Note that the various sweep parameters (e.g. start, stop, time) must have been previously set.

P3

Syntax: P3

Description: Sending this command will cause the Ramp Power Sweep to stop. The power may now be adjusted manually.

PA

Syntax: PA *d* DM

Example: PA 2 DM ! Set the Ramp Power Sweep start to 2 dBm

Description: Sets the start power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep.

If the PA command is sent with no variable it makes start power the active variable. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep.

PB

Syntax: PB *d* DM

Example: PB 8 DM ! Set the Ramp Power Sweep stop to 8 dBm

Description: Sets the stop power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep. If the PB command is sent with no variable, it makes stop power the active variable. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep

PC

Syntax: PC *d* [S | MS | US]

Example: PC 5 MS ! Set the Ramp Power Sweep time to 5 ms

Description: Sets the time for a Ramp Power Sweep to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep. If the PC command is sent with no variable it makes Power Sweep time the active variable. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep

PS

Syntax: PS

Example: PS 1 ! Activate Ramp Power Sweep

Description: This command activates (PS 1) or deactivates (PS 0) the Ramp Power Sweep.

RS

Syntax: RS

Description: This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

TR

Syntax: TR *n*

Example: TR 2 ! Sets the current sweep trigger to immediate

Description: Sets the trigger condition for the current sweep as specified by the value *n*:

n = 0: Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 1: Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.

n = 2: Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.4.13 Amplitude Modulation Commands

The Amplitude Modulation command set selects of the source of modulation and the modulation depth. If Option 24 is installed, the various parameters of the internal generator are able to be set.

- **AD**
- **AM**
- **AMF**
- **AR**
- **SC**
- **SD**
- **SR**

AD

Syntax: AD *d*

Example: AD 40 ! Set the AM depth to 40%

Description: Sets the depth of Amplitude Modulation to *d* percent.

AM

Syntax: AM *n*

Example: AM 1 ! Activate external AM

Description: Activates and selects the source of the AM according to the following values for *n*. Note that this command applies to linear AM. Commands to activate and select the Scan AM are [SC]

n = 0 Deactivate (turn off) Amplitude Modulation
n = 1 Activate external Amplitude Modulation
n = 2 Activate internal Amplitude Modulation (only with Option 24) and select sine wave
n = 3 Activate internal Amplitude Modulation (only with Option 24) and select square wave
n = 4 Activate internal Amplitude Modulation (only with Option 24) and select triangle wave.
n = 5 Activate internal Amplitude Modulation (only with Option 24) and select positive ramp.
n = 6 Activate internal Amplitude Modulation (only with Option 24) and select negative ramp.
n = 7 Activate internal Amplitude Modulation (only with Option 24) and select noise.
n = 8 Activate internal Amplitude Modulation (only with Option 24) and select zero output.

AMF

Syntax: AMF *n*

Example: AMF 1 ! Activate external AM

Description: The AMF set of commands duplicate the functions of the AM commands listed above. This command group is included for compatibility with older Giga-tronics instruments.

AR

Syntax: AR *d* [Hz | KZ | MZ |GZ]

Example: AR 400 HZ ! Set the internal AM rate to 400 Hz

Description: Sets the rate of the internal amplitude modulation generator to *d* [Hz | KZ | MZ |GZ]. This command is valid only with Option 24.

SC

Syntax: SC *n*

Example: SC 1 ! Activate external Scan AM

Description: Activates and selects the source of the Scan AM according to the following values for *n*:

n = 0	Deactivate (turn off) Scan Amplitude Modulation.
n = 1	Activate external Scan Amplitude Modulation.
n = 2	Activate internal Scan Amplitude Modulation (only with Option 24) and select sine wave.
n = 3	Activate internal Scan Amplitude Modulation (only with Option 24) and select square wave.
n = 4	Activate internal Scan Amplitude Modulation (only with Option 24) and select triangle wave.
n = 5	Activate variable attenuation. In this mode no internal or external signal is applied. The setting of the Scan depth ([SD]) determines the amount of attenuation provided.
n = 6	Activate internal scan (only with Option 24) and select positive ramp.
n = 7	Activate internal scan (only with Option 24) and select negative ramp.
n = 8	Activate internal scan (only with Option 24) and select noise.
n = 9	Activate internal scan (only with Option 24) and select zero output.
	Note that this command applies to Scan AM. Commands to activate and select the linear AM are [AM <*Num_Val*>]

SD

Syntax: SD *d*

Example: SD 40 ! Set the Scan depth to 40 dB

Description: Sets the depth of Amplitude Modulation to *d* dB.

Note that the AM source needs to be set prior to using this command since the external depth and internal depth are independent variables.

SR

Syntax: SR *d* [Hz | KZ | MZ |GZ]

Example: SR 400 HZ ! Set the internal AM rate to 400 Hz

Description: Sets the rate of the internal amplitude modulation generator to *d* [Hz | KZ | MZ |GZ]. This command is valid only with Option 24.

3.4.14 Frequency Modulation Commands

The Frequency Modulation command set selects of the source of modulation and the modulation deviation. If Option 24 is installed, the various parameters of the internal generator are able to be set.

- **FD**
- **FM**
- **FR**
- **FT**
- **NM**

FD

Syntax: FD *d* [HZ | KZ | MZ | GZ]

Example: FM 500 KZ ! Activate FM with a 500 kHz deviation

Description: Allows setting the deviation to *d* [HZ | KZ | MZ | GZ], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. If the FM mode is Phase, then this command sets the deviation in Radians (with any units key the terminator).

FM

Syntax: FM *n*

Example: FM 1 ! Activate External FM

Description: Activates and selects the source of the FM according to the following values for *n*. Note that this command applies to Narrow, Wide and Phase modes. See the FT command.

n = 0 Deactivate (turn off) Frequency Modulation.

n = 1 Activate external Frequency Modulation.

n = 2 Activate internal Frequency Modulation (only with Option 24) and select sine wave.

n = 3 Activate internal Frequency Modulation (only with Option 24) and select square wave.

n = 4 Activate internal Frequency Modulation (only with Option 24) and select triangle wave.

n = 5 Activate internal Frequency Modulation (only with Option 24) and select positive ramp.

n = 6 Activate internal Frequency Modulation (only with Option 24) and select negative ramp.

n = 7 Activate internal Frequency Modulation (only with Option 24) and select zero output.

FR

Syntax: FR *d* [Hz | KZ | MZ |GZ]

Example: FR 400 HZ ! Set the internal FM rate to 400 Hz

Description: Sets the rate of the internal frequency modulation generator to *d* [Hz | KZ | MZ |GZ]. This command is valid only with Option 24.

FT

Syntax: FT *n*

Example: FT 1 ! Set FM to Narrow mode

Description: This command sets the mode for Frequency Modulation. The following modes are available for the value of *n*:

1 = Narrow mode

2 = Wide mode

3 = Phase mode, narrow

4 = Phase mode, wide

NM

Syntax: NM ! Toggle to the next FM mode

Description: This command sets the FM mode to the next type. Available types are: Narrow, Wide, Phase, Narrow and Phase Wide.

3.4.15 Pulse Modulation Commands

The Pulse Modulation command set selects of the source of modulation and the delay. If Option 24 is installed, the various parameters of the internal generator are able to be set.

- **PM**
- **PR**
- **PW**
- **PY**
- **SHPM**

PM

Syntax: PM *n*

Example: PM 1 ! Activate external PM

Description: Activates and selects the source of the PM according to the following values for *n*:

n = 0 Deactivate (turn off) Pulse Modulation
n = 1 Activate external positive true Pulse Modulation
n = 2 Activate internal Pulse Modulation (with Option 24 only)
n = 3 Activate external negative true Pulse Modulation
n = 4 Activate external rising edge trigger Pulse Modulation (with Option 24 only)
n = 5 Activate external falling edge trigger Pulse Modulation (with Option 24 only)

PR

Syntax: PR *d* [HZ | KZ | MZ | GZ]

Example: PR 500 KZ ! Set PM rate to 500 kHz

Description: Sets the rate to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. This command requires Option 24 to be installed.

The internal modulation generator does not allow the rate and start delay to be sent independently. If the PR command is sent, the start delay is adjusted to produce the desired rate. The pulse width and interval delays are adjustable within the requested period (1/rate).

PW

Syntax: PW *d* [S | MS | US]

Example: PW 5 MS ! Set PM width to 5 ms

Description: Sets the width for an internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. This command requires Option 24 to be installed.

If rate has been selected, the pulse width is adjustable only within the requested period (1/rate).

PWV

Syntax: PWV *n*

Example: PWV 1 ! Activate singlet waveform

Description: Selects the waveform generated by the internal pulse modulation generator according to the following values for n:

n = 0	Selects no waveform
n = 1	Selects singlet waveform
n = 2	Selects doublet waveform
n = 3	Selects triplet waveform
n = 4	Selects quadlet waveform

PI

Syntax: PI *d* [S | MS | US]

Example: PI 5 MS ! Set 5 ms interval delay

Description: Sets the interval display between pulses (doublet, triplet, quadlet) generated by the internal pulse modulation generator, where d is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. *This command requires Option 24 to be installed.*

PY

Syntax: PY *d* [S | MS | US]

Example: PY 5 MS ! Set PM delay to 5 ms

Description: Sets the delay for an externally triggered or internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. *This command requires Option 24 to be installed.*

The internal modulation generator does not allow the rate and start delay to be sent independently. If the PY command is sent, the period of repetition becomes a function of the star delay, pulse width, interval delay, and waveform type (singlet, doublet, etc.) as follows:

start delay + ((pulse width + interval delay)(number of pulses))

SHPM

Syntax: SHPM

Description: This command is included for compatibility with systems using Hewlett Packard (Agilent) model 8757A scalar analyzers. It will turn on external Pulse Modulation.

3.4.16 Output Commands

This series of commands allows a remote controller to read the values of many of the instrument parameters. The returned string is a decimal number expressed in base units (Hz for frequency, seconds for time, dBm for power). See examples following. Note that this series of commands causes the instrument output buffer to be loaded with the desired result. The remote controller must then do a read to obtain the data.

- **OA**
- **OC**
- **OD**
- **OI**
- **OPAS**
- **OPCF**
- **OPCW**
- **OPDF**
- **OPFA**
- **OPFB**
- **OPM**
- **OPPL**
- **OPSF**
- **OR**

OA

Syntax: OA

Example: OA

Response: Returns a string showing the value of the active variable.

Example: 9000000000.0 (Frequency of 9 GHz)

Description: Whenever a command is sent to change a parameter, that parameter becomes the active variable. Sending the OA command will then return the value of that variable.

OC

Syntax: OC

Example: OC

Response: Returns a string containing first the start frequency, then the center frequency, and last the sweep time. A space separates each value.

Example: 9000000000.0 12000000000.0 .005

Description: This command outputs the coupled parameters found in center/delta frequency sweeps. The above example shows a sweep starting at 9 GHz, with a 12 GHz center frequency, and a sweep time of 5 ms.

OD

Syntax: OD

Example: OD

Response: Returns a string containing five digits Each is a zero or a one. See below for the meaning of each digit. A space separates each value.

Example: 1 1 1 0 0

Description: This command outputs the results of instrument self-test (see SHM4). The self-test steps the instrument across its frequency range and checks for lock and level at each step. Three circuits are monitored: The main PLL, the tracking filter PLL and the ALC loop. The first three digits returned represent (in order) these three areas. The last two are reserved for future use. If at the end of the self-test any failures have been recorded, the appropriate digit will be set to a zero. Digits set to a one indicate no failures. The OD command must be sent following self-test to send the string.

OI

Syntax: OI

Description: TBA

OPAS

Syntax: OPAS *d*

Description: TBA

OPCF

Syntax: OPCF

Example: OPCF

Response: Returns a string containing the center frequency of a sweep.

Example: 9000000000.0 (A center frequency of 9 GHz)

Description: When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OPCW

Syntax: OPCW

Example: OPCW

Response: Returns a string containing the current CW frequency.

Example: 4500000.0 (A CW frequency of 4.5 MHz)

Description: The value of the current value of the CW frequency will be returned, even if the instrument is in a different mode

OPDF

Syntax: OPDF

Example: OPDF

Response: Returns a string containing the delta frequency of a sweep.

Example: 6000000000.0 (A delta sweep value of 6 GHz)

Description: When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep delta frequency.

OPFA

Syntax: OPFA

Example: OPFA

Response: Returns a string containing the start frequency of a sweep.

Example: 2500000000.0 (A start frequency of 2.5 GHz)

Description: When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep start frequency.

OPFB

Syntax: OPFB

Example: OPFB

Response: Returns a string containing the stop frequency of a sweep.

Example: 6500000000.0 (A start frequency of 6.5 GHz)

Description: When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep stop frequency.

OPM

Syntax: OPM *n*

Example: OPM 3

Response: Returns a string with the value for the selected marker frequency.

Example: 5552000.0 (Marker 3 at a frequency of 5.552 MHz)

Description: This command allows interrogating each of the twelve markers to determine the frequency to which it is set. Send OPM *n* where *n* is the marker number.

OPPL

Syntax: OPPL

Example: OPPL

Response: Returns a string containing the value of the output power in dBm.

Example: -15.3 (An output power of -15.3 dBm)

Description: The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep).

OPSF

Syntax: OPSF

Example: OPSF

Response: Returns a string containing the center frequency of a sweep.

Example: 100.0 (A step size of 100 Hz)

Description: When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OR

Syntax: OR

Example: OR

Response: Returns a string containing the value of the output power in dBm.

Example: -15.3 (An output power of -15.3 dBm)

Description: The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep). This command is identical in operation to OPPL and is included for compatibility with older Hewlett Packard (Agilent) instruments.

3.4.17 ALC Commands

- A
- AT
- SHA1
- SHPS
- SHRF
- SHSL
- SHRL

A

Syntax: A *n*

Example: A 1 ! Select Internal Leveling

Description: Selects the leveling method according to the following values for *n*.

n = 1 Selects internal leveling.

n = 2 Selects external leveling using a negative diode detector

n = 3 Selects external leveling using the DC output of a power meter

AT

Syntax: AT *d* DB

Example: AT80DB ! Sets the attenuator to 80 dB

Description: Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. To use this command, the attenuator must first be uncoupled from the level control by sending SHSL. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching.

SHA1

Syntax: SHA1

Description: This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHPS

Syntax: SHPS *d* DB

Example: SHPS80DB ! Sets the attenuator to 80 dB

Description: Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHRF

Syntax: SHRF

Description: This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHSL

Syntax: SHSL *d* DB

Example: SHSL80DB ! Sets the attenuator to 80 dB

Description: Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHRL

Syntax: SHRL

Description: Re-couples the attenuator to the leveling control system. The step attenuator will now switch at each 10 dB boundary of the level range.

3.4.18 Instrument Control Commands

- CS
- DN
- DU
- EF
- EK
- IH
- IP
- NSR
- PH2
- RC
- RFD
- SHM4
- SHS1
- SV
- UP

CS

Syntax: CS

Description: Clears the 16-bit status bytes that report the instrument status.

DN

Syntax: DN

Description: Decreases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending DN will decrease the frequency by 100 MHz. Equivalent to pressing the Down Button.

DU

Syntax: DU *n*

Example: DU 1 ! Displays 'Remote Operation'

Description: This command specifies what will be displayed on the instrument screen during GPIB operation. The (currently) valid values of *n* are: 0 Leaves the screen blank. 1 Displays **Remote Operation** on the screen. 2 Displays normal menus during GPIB operation. Reports any errors on the message line. 3 Displays normal menus and writes on the message line (bottom line of the screen) each GPIB command as it's received (marked *Recd:*) and after it's executed (marked *Done:*). Reports any errors on the message line. 6 Scrolls up the screen the most recent 12 GPIB commands received (marked *Recd:*) and executed (marked *Done:*). Leaves the bottom line free to report errors.

EF

Syntax EF

Description Disables the front panel knob to prevent inadvertent parameter changes.

EK

Syntax EK

Description Enables the front panel knob.

IH

Syntax IH

Description Clears all lists, level-correction tables and setups from non-volatile memory; writes zeros to the cleared memory locations. Reinitializes the heap-space manager.

IP

Syntax IP

Description Sets all instrument settings to factory values; sets the instrument to CW mode at the instrument's minimum frequency. Clears all lists, level-correction tables and setups from non-volatile memory and reinitializes the heap-space manager.

NSR

Syntax NSR

Description The normal operation of the remote mode displays the words **Remote Operation** on the screen. Sending NSR will cause the screen to show the same information displayed when in local mode. For example if the CW command were to be sent, the 'Fixed Frequency' menu will be displayed. The NSR command is a 'toggle'. Each time it is sent the screen display toggles from **Remote Operation** to standard menu.

PH2

Syntax PH2

Description In instruments with Option 20, this command will force the instrument control system to always keep the high power amplifier module in the circuit. Normally, the high power amplifiers are only used if the output RF power is set to +15 dBm or higher. This command is used primarily for doing the level characterization. Leaving the high power amplifiers in place at low power levels will cause accuracy errors as well as added noise.

RC

Syntax RC *n*

Example RC 1 ! Recall front panel setup #1

Description Recalls the selected front panel setup from non-volatile memory. There are ten memory locations, 0-9.

RFD

Syntax: RFD *n*

Example: RFD 1 ! RF on during frequency change

Description: The RF output of the instrument is normally reduced by about 40 dB during frequency changes to prevent any potential damaging overshoot (to a users equipment, not the instrument). Sending RFD1 will disable this feature and leave the RF on at all times except band and filter crossing points. Sending RFD0 re-enables the normal operation.

SHM4

Syntax: SHM4 *d* [HZ | KZ | MZ | GZ]

Example: SHM4 100MZ ! Run Self Test in 100 MHz steps

Description: Activates Self Test and allows setting the step size to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency increment (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. Self test will step the instrument over its entire frequency range in the selected steps. If any of the monitored functions exhibit failures, the appropriate bit is set in the diagnostic register. See OD for a description of the output string.

SHS

Syntax: SHS *n*

Example: SHS1 ! Blank the display

Description: Sending SHS1 will completely blank the front panel display. This feature is provided for those applications requiring security. Sending SHS0 turns the display back on.

SV

Syntax: SV *n*

Example: SV 1 ! Save front panel setup in #1

Description: Saves the current front panel setup in non-volatile memory. There are ten memory locations, 0-9. All instrument parameters are saved, including modes not currently active.

UP

Syntax: UP

Description: Increases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending UP will increase the frequency by 100 MHz. Equivalent to pressing the Up Button.

4

Performance Test and Calibration

4.1 Introduction

This chapter provides step-by-step procedures to verify performance of the Series 12000A Microwave Synthesizers.

The required warm-up time before testing is 72 hours. The warm-up period can be reduced to 30 minutes if timebase accuracy is not to be tested.

In these procedures, the instrument being tested may be referred to as the 12000A or UUT (Unit Under Test).

4.1.1 Recommended Equipment

The following equipment is recommended before starting the performance test routines (the recommended equipment can be substituted provided the specifications are sufficiently compatible):

- Frequency Standard, 10 MHz
- Oscilloscope, Tektronix 2465 or equivalent
- Microwave Frequency Counter, Systron Donner 6245B or equivalent
- Power Meter and Sensor, Giga-tronics 8541A/8651A with 80313A sensor, or equivalent
- Spectrum Analyzer, HP 8566B or equivalent
- Detector, Herotek Model DZ262-44 or equivalent
- Function (Audio) Generator, Wavetek 191 or equivalent
- Measuring Receiver, HP 8902A or equivalent
- Distortion Analyzer, HP 339A or equivalent
- L.O. Generator, Giga-tronics Microwave Synthesizer
- Universal Counter, Racal Dana 1994 or equivalent
- Mixer IF Amplifier with Divide-by-40 output
  (Giga-tronics Mixer/Divider, Part Number 002CA04900)

4.2 Performance Tests

4.2.1 Introduction

The procedures in this section verify the electrical performance of the 12000A using the specifications in Chapter 1.

Each of the performance tests includes a list of recommended test equipment. There is a consolidated list at the beginning of this chapter. Equivalent test equipment can be substituted provided that the accuracies and specifications are sufficiently compatible.

A test data sheet is included for you to enter the various readings taken. The specification and tolerance range is listed for ease of verification. It is suggested that copies be made of the manual sheets. When automated tests are run, a printed data sheet is produced.

Performance verification is recommended at least every two years, or more often when required to ensure proper operation of the instrument.

Each procedure specifies a required warm-up time if the procedure is to be done individually. Only one warm-up period is required for a sequence of tests. Test equipment must be warmed up according to specifications.

4.2.2 Frequency Range, Resolution and Accuracy

Description:

Connect the 12000A RF output to the input of a frequency counter. The internal time base of the counter is a reference for the 12000A to eliminate time base errors from the measurements. This procedure does not check for time base accuracy, and therefore the frequency in the 12000A display should agree with the counter, within the resolution of each instrument.

It is possible for a fault in the 12000A to cause a frequency error even though the lock indicators show normal operation. For this reason a number of specific frequencies are tested. Test frequencies have been selected so that any defective circuits will be easily isolated.

Equipment Required:

UUT • Frequency Counter • Coaxial Cable

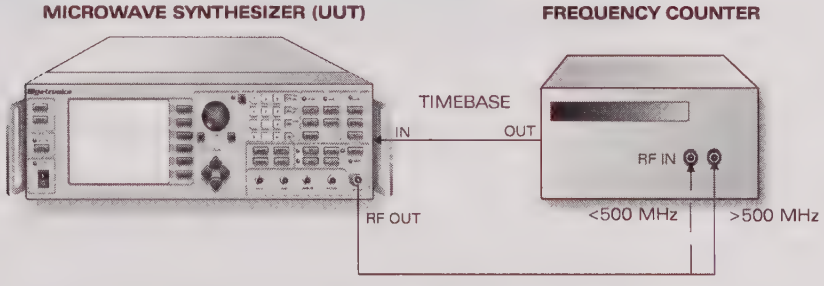

Figure 4-1: Frequency Range, Resolution and Accuracy

Procedure:

NOTE: *Steps 1 through 4 are used only for instruments operating down to 10 MHz.*

1. Connect the equipment as shown in Figure 4-1. Connect the 12000A RF Output to the 10 to 500 MHz counter input using the coaxial cable and the SMA to BNC adapter. Allow the equipment to warm up for at least 30 minutes. Because the 12000A and the counter use the same time base, time base errors are eliminated. The 12000A will automatically switch to the external reference when it is connected.

2. Set the 12000A to 10 MHz. Press **[LEVEL]** in the POWER field and enter **[-] [1] [0] [dBm]**. Press **[RF ON]** in the RF OUTPUT field to turn on the RF output.

3. Set the 12000A to each frequency listed on the data sheet and verify that the counter reads the set frequency plus or minus the counter resolution. This tests each divider stage.

4. Connect the 12000A RF Output to the 500 MHz to 26.5 GHz input on the counter, and continue with the divider tests.

5. To check that the multipliers are functioning properly, refer to the test data sheet and program each of the listed frequencies into the 12000A by entering (for example) **[CW] [2] [0] [0] [1] [MHz]**. For each listed frequency the counter should read the entered frequency ±1 Hz, plus or minus the counter resolution. Ignore all frequencies outside the range of the instrument under test.

4.2.3 Spurious Signals Tests

Description:

The output of the 12000A is connected to a spectrum analyzer. Various frequencies are selected and the analyzer tuned to determine the presence of either harmonically or non-harmonically spurious signals.

Equipment Required:

UUT • Spectrum Analyzer • Coaxial Cable

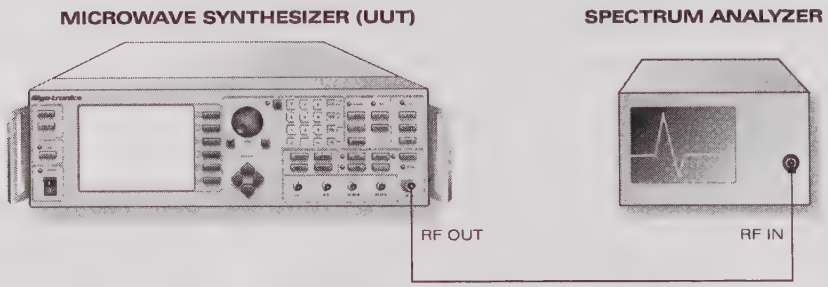

Figure 4-2: Spurious Signals Tests

Procedure:

1. Connect the equipment as shown in Figure 4-2. Allow the equipment to warm up for at least 30 minutes. Press **[CW]** in the FREQUENCY field on the 12000A and enter the first test data sheet frequency within the range of the 12000A. The RF amplitude should be at +6 dBm. Press **[RF ON]** to turn on the RF output. Be certain that all modulation is OFF.

2. Set the spectrum analyzer to view the 12000A output signal. Adjust the analyzer reference level so that the peak of the displayed signal is at the top graticule line.

3. Set the spectrum analyzer to maximum span with the signal centered on the screen. Gradually narrow the span, keeping the signal centered, to observe any spurious signals. Use appropriate resolution and video bandwidths to allow sufficient dynamic range.

4. Repeat steps 2 and 3 for the other frequencies on the test data sheet which are within the operating range of the instrument.

Many spectrum analyzers have a tuned preselector when the frequency is above about 2 GHz. This reduces the likelihood of analyzer generated spurious signals, but does not eliminate the possibility. If in doubt, increase the RF attenuation of the analyzer by 10 dB. The signal in question should be reduced by exactly 10 dB. If not, it is analyzer generated. It is also important for frequencies below the range of the preselector that sufficient analyzer RF Attenuation be used (typically 30 dB) to avoid the analyzer generating harmonics of the input signal. The above attenuator shift technique will also allow verification of harmonic levels.

If a spurious signal appears to be out of specification, first check that the fundamental signal level is at +6 dBm. Next verify the analyzer accuracy by connecting a known amplitude signal (from the 12000A, for example) at the spurious frequency.

The adjusting knob on the 12000A may generate some noise spikes when it is rotated. The acquisition of the various phase lock loops in the instrument can also cause transients (within the specified settling time). Both of these effects will disappear when a steady state condition has been reached.

It is important to identify the particular class of spurious signal as the specifications may be different for each. If the spurious signal is an exact multiple of the 12000A RF output then the harmonic specification applies. Any other spurious signals must meet the non-harmonically related specification.

For frequencies above the fundamental range of the spectrum analyzer, either a mixer supplied with the spectrum analyzer or an external mixer and local oscillator may be used to downconvert the signal. Care must be taken to identify spurious signals which are inherently generated by the mixing process.

4.2.4 Single Sideband Phase Noise

Description:

The test in this procedure is limited by the measuring system and verifies only the majority of the phase noise specification. To completely test the phase noise specification requires a far more sophisticated measurement system. This test uses the spectrum analyzer to make all measurements from 100 Hz to 1 MHz offsets. The 100 Hz and 1 MHz offsets are particularly susceptible to measurement system limitations.

Equipment Required:

UUT • Spectrum Analyzer • Coaxial Cable

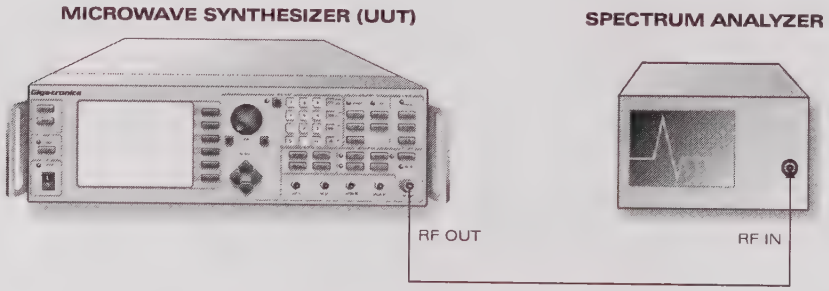

Figure 4-3: Single Sideband Phase Noise

Procedure:

1. Connect the 12000A RF output to the spectrum analyzer input. Place the 12000A on a foam pad to isolate it from any external mechanical vibrations, which could affect the phase noise measurement.

2. Turn off all modulation on the 12000A.

3. For the first frequency on the test data sheet within the range of the instrument, press **[CW]** and enter the frequency. Tune the spectrum analyzer to the generator frequency and adjust the 12000A RF level to obtain a reference of 0 dBm on the analyzer. This allows direct measurement of the phase noise by the analyzer.

4. Set the analyzer span such that the desired offset is at ±2 divisions, select an appropriate bandwidth, activate the phase noise measurement and place the marker two divisions to the right of the carrier. Read the phase noise in dBc/Hz. Repeat for all offsets.

5. Repeat steps 3 and 4 for the other test data sheet frequencies which are within range of the 12000A.

4.2.5 RF Output Power Tests

Description:

Although it is possible to make the following measurements manually, it is extremely tedious. It is recommended that an automated system be set up to take and record the data. Three tests are run. The first measures the maximum available output with the level control loop disabled. The second verifies the accuracy and flatness across the operating frequency range at a fixed output (0 dBm). The remaining test checks the step attenuator accuracy at a number of frequencies. This section outlines the general procedure followed by the automated system, a similar measurement could be done manually.

Equipment Required:

UUT • Local Oscillator • Measuring Receiver & Sensor • Downcoverter • Plotter • Computer and Programs

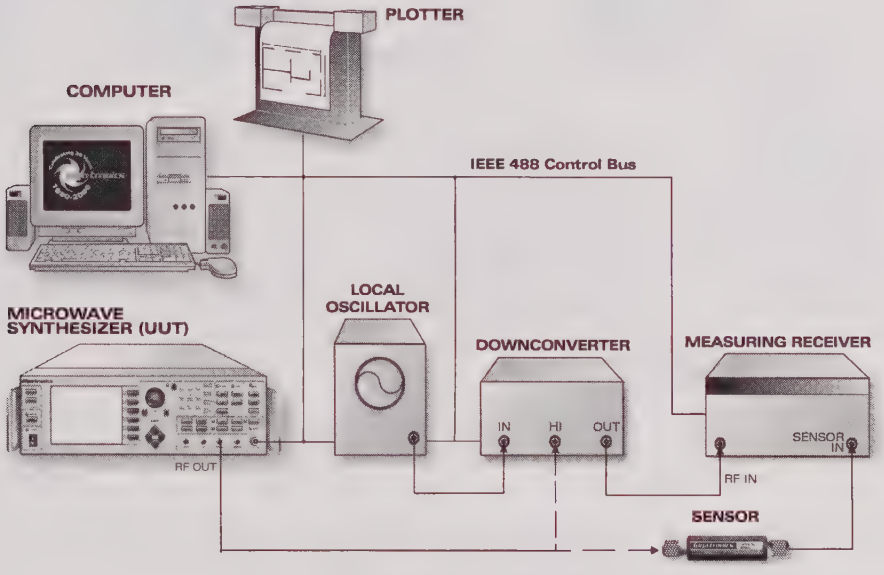

Figure 4-4: RF Output Power Tests

Procedure:

1. Connect the power sensor to the 12000A. Disable the leveling system of the 12000A. Step the frequency across the particular instrument operating range in 50 MHz increments. At each point measure the power, apply the appropriate sensor correction factor, and plot the result.

2. Using the above setup, set the 12000A to 0 dBm with the leveling enabled. Again, step the frequency across the operating range; measure, correct, and plot the power.

3. *For instruments with Option 26 -* Connect the 12000A to the measuring receiver via the downconverter. With the 12000A at 0 dBm and set to the first test frequency, establish a reference on the receiver. Reduce the 12000A output in 10 dB steps, observing and recording the receiver reading. As needed, perform the recalibration requested by the receiver.

4. Repeat this procedure for the remaining test frequencies.

NOTE: *When measuring the flatness and accuracy of the model 12000A, consideration must be given to the various measurement uncertainties in the test system. These include, but are not limited to, VSWR, Cal Factor uncertainty and calibration.*

4.2.6 Pulse Modulation On/Off Ratio Test

Description:

The 12000A is set to a CW frequency at a power level of 0 dBm. A spectrum analyzer is used to view the signal. The pulse modulation is then enabled and the resulting waveform is measured.

Equipment Required:

UUT • Spectrum Analyzer • Pulse Generator • Coaxial Cable

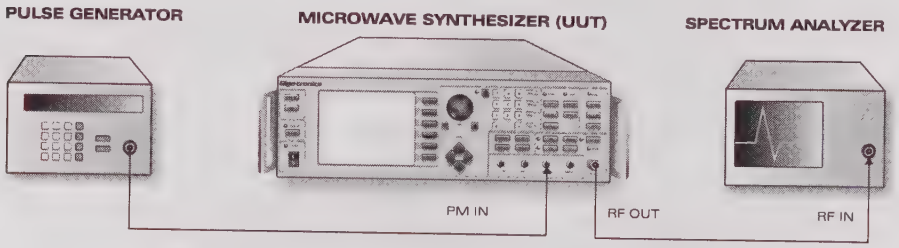

Figure 4-5: Pulse Modulation On/Off Ratio Test

Procedure:

1. Connect the equipment as shown in Figure 4-5. Allow 30 minutes warm-up time.

2. Enter the first frequency on the test data sheet within the frequency range of the instrument. The RF power level should be at 0 dBm. Select external pulse modulation (PM) on the 12000A.

3. Tune the analyzer to the source frequency, select an analyzer span of 0 Hz and fine tune the analyzer to place the line at the top of the screen graticule (adjust analyzer reference level as needed).

4. Set the pulse generator for a 100 Hz square wave; press **[PULSE]** then use the softkey to turn on the pulse modulation.

5. Adjust the analyzer sweep time to display a few cycles of the waveform. Use internal triggering. Reduce resolution bandwidth and carefully retune the analyzer center frequency until the maximum resolution is achieved. Read and record the peak-to-peak value (use marker delta).

6. Repeat steps 3, 4 and 5 for all other test data sheet frequencies which are within the range of the instrument. Note that the dynamic range of the analyzer may limit its measurement capability.

4.2.7 Pulse Modulation Rise and Fall Time Test

Description:

A crystal detector is connected to the 12000A, terminated in 50 Ω, and monitored with an oscilloscope.

> ***NOTE:*** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

Equipment Required:

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable

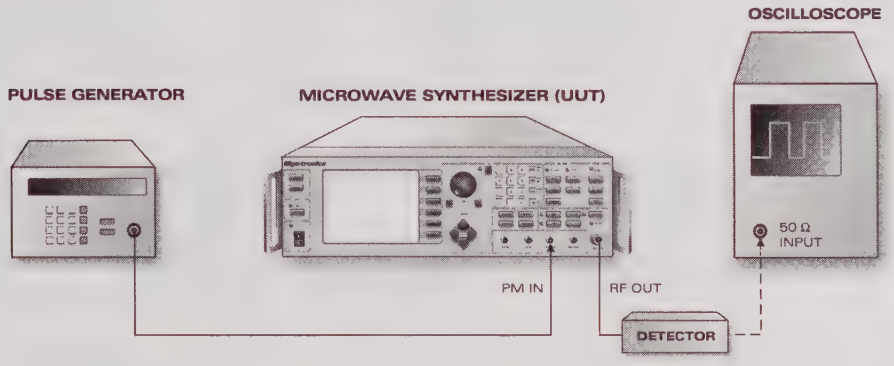

Figure 4-6: Pulse Modulation Rise/Fall Time Test

Procedure:

1. Connect the equipment as shown in Figure 4-6. The cable from the detector to the oscilloscope should be kept as short as possible.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Enable external pulse modulation (at a 1 MHz rate and 0.5 µs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

4. Set the oscilloscope to 5 mV/div and using the RF Level control of the 12000A, adjust the peak to peak oscilloscope display to fall on the dotted lines on the screen (100% and 0%). Adjust the oscilloscope sweep time to 5 ns/div. Measure and record the rise and fall times between the 10% and 90% points.

5. Repeat Step 4 for each of the test data sheet frequencies within the operating range of the instrument.

4.2.8 Pulse Modulation Overshoot and Settling Time

Description:

A crystal detector is connected to the 12000A, terminated in 50 Ω, and monitored with an oscilloscope.

> ***NOTE:*** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

Equipment Required:

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable

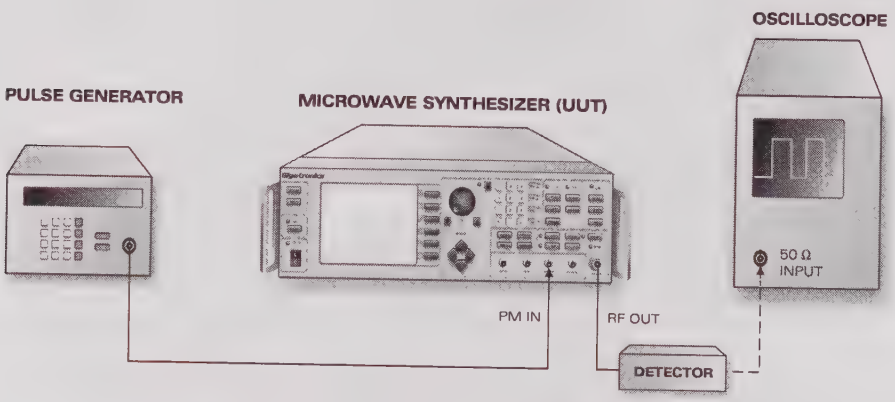

Figure 4-7: PM Overshoot and Setting Time

Procedure:

1. Connect the equipment as shown in Figure 4-7. The cable from the detector to the oscilloscope should be kept as short as possible.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Enable external pulse modulation (at a 1 MHz rate and 0.5 ms width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

4. Set the oscilloscope to 5 mv/div and using the RF Level control of the 12000A and the vertical position of the oscilloscope, adjust the peak to peak oscilloscope display to be from the top of the screen (pulse off) to 2 divisions below the center line (pulse on). Adjust the oscilloscope sweep time to 50 ns/div. Change the level setting of the 12000A by plus and minus 1 dB and note the graticule position of the pulse on level. Return to the original value. Measure and record the time for the pulse to be within 1 dB of its final value.

5. Change the level setting of the 12000A by plus and minus 2 dB and note the graticule position of the pulse on level. Return to the original level. Measure and record any undershoot/ overshoot of the signal.

6. Repeat Steps 4 and 5 for each of the test data sheet frequencies within the operating range of the instrument.

4.2.9 Pulse Modulation Accuracy Test

Description:

In this test the peak pulse level is compared to the level in the CW mode.

Equipment Required:

UUT • Oscilloscope • Pulse Generator • Crystal Detector • Coaxial Cable

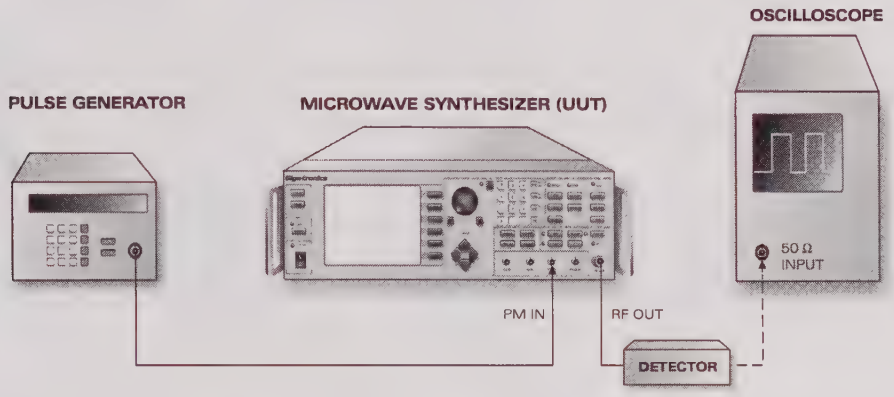

Figure 4-8: Pulse Modulation Accuracy Test

Procedure:

1. Connect the equipment as shown in Figure 4-8. The oscilloscope input impedance should be 50 Ω. Allow 30 minutes warm-up.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Set the oscilloscope to 5 mv/div and using the vertical position of the oscilloscope, adjust the trace to the centerline of the screen. Change the level setting of the 12000A by plus and minus 1 dB and note the trace position on the screen. Return to 0 dBm.

4. Enable external pulse modulation (at a 200 kHz rate and 0.1 µs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

5. Measure and record the difference between the CW reference level and the negative peak of the pulse.

6. Change the pulse width to 50 ns and again measure and record the difference between the CW reference level and the negative peak of the pulse.

7. Repeat Steps 3-6 for each test data sheet frequency within the operating range of the instrument.

4.2.10 Frequency Modulation Tests

Description:

The output from the 12000A is connected to a discriminator. The discriminator output is monitored on an oscilloscope to determine deviation and bandwidth.

Equipment Required:

UUT • Function Generator • Oscilloscope • Digital Voltmeter • FM Test Fixture

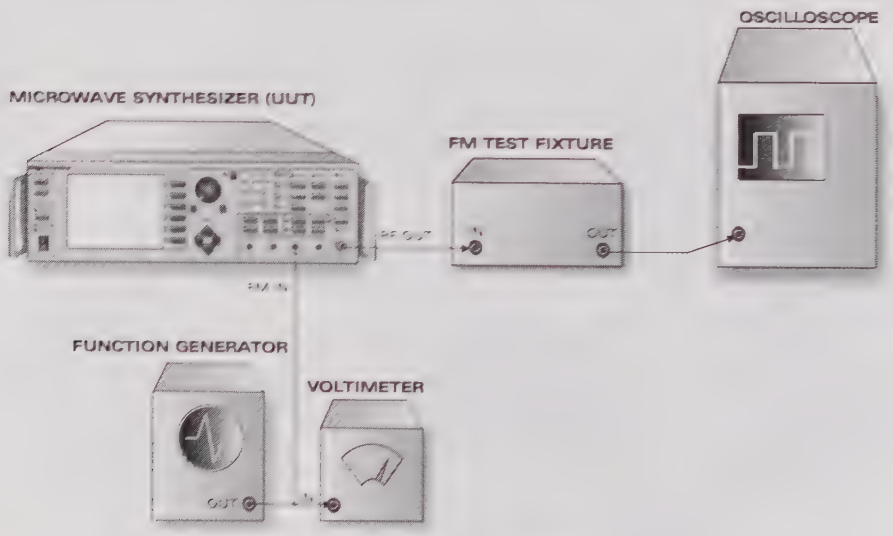

Figure 4-9: Frequency Modulation Test

Procedure:

In order to calibrate and test the frequency modulation circuits, a special test fixture must be assembled. The recommended FM test fixture includes an RF splitter, two lines of unequal length, and an RF mixer. The RF output of the 12000A is divided by the splitter into two signals, unequally delayed. The required differential delay can be obtained by using two coaxial cables of, for example, 5 and 10 inches in length. The outputs of these delay lines are furnished to the two inputs of the RF mixer. For certain frequencies, which may be identified by experiment, the mixer will produce a DC voltage near zero. The number of null frequencies can be increased by making the delay lines longer in absolute terms or by increasing the ratio between their lengths. If the output becomes frequency modulated, the mixer output voltage will change, and the voltage variation will be proportional to FM deviation. The polarity of the voltage change may be either directly or inversely related to the direction of frequency deviation. When voltage levels have been established for different frequencies, the mixer output can be monitored on an oscilloscope to provide a continuous display of FM deviation.

1. Connect the FM test fixture to the RF OUT connector of the 12000A as shown in Figure 4-9. Monitor the mixer output with the oscilloscope (5 mV/div). Set the 12000A to any null frequency between 4.0 and 7.99 GHz (that is, at a frequency where the mixer output voltage is zero); +10 dBm out, no modulation.

2. Establish the voltage at 1 MHz above and 1 MHz below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 1 MHz deviation points at 3 divisions above and 3 divisions below the null point.

3. Set the 12000A to Narrow EXT FM with 1 MHz deviation. Connect the function generator, set to a 100 kHz rate SINE wave, 2 V_{p-p}. Verify that the waveform is 6 divisions peak-to-peak (±0.3 divisions).

4. Adjust the 12000A FM deviation for exactly a six division peak-to-peak display. Vary the function generator from 10 Hz to 1 MHz and verify that the display remains between five and seven divisions peak-to-peak.

5. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

6. Establish the voltage at 10 MHz above and below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 10 MHz deviation points at 3 divisions above and 3 divisions below the null point (terminate the Mixer output in 50 Ω).

7. Set the 12000A to Wide EXT FM with 10 MHz deviation. Set the function generator to 100 kHz. Verify that the waveform is 6 divisions peak-to-peak (±0.3 divisions).

8. Adjust the 12000A FM deviation for exactly a 6-division peak-to-peak display. Vary the function generator from 100 Hz to 1 MHz and verify that the display remains between 5 and 7 divisions.

9. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

4.3 Calibration

Calibration is recommended every two years.

The Model 12000A features closed-case calibration. There are no mechanical adjustments of any kind in the instrument. All calibration is done under the control and direction of the calibration software. Calibration data is stored in non-volatile RAM.

There are four functions in the instrument that require periodic calibration using external sources or measurement equipment:

- Time Base
- Output Amplitude
- Frequency Modulation
- Amplitude Modulation

Other instrument functions are adjusted either at instrument turn-on or during operation. In addition to the user-initiated and automatic calibrations, there are certain factory calibration processes. The first four sections describe in general terms how user-initiated calibration is accomplished. The actual calibration process is directed by the calibration software. The remaining sections describe the adjustments that occur at power-up or when certain modes are selected, and the factory calibration processes.

The equipment required to perform user-initiated calibration consists of (1) a known accurate 5 or 10 MHz source, (2) a Giga-tronics 8540 or 8650 Universal Power Meter with an 80303A or equivalent power sensor, (3) a 1.00 to 6.00 Vdc source (this source can be a stable power supply and a voltmeter with 1% or better accuracy).

4.3.1 Timebase Calibration

The model 12000A uses an internal 10 MHz oven oscillator to provide a frequency reference for the synthesizer and other associated circuits. The oscillator uses Electronic Frequency Control for its adjustment. Before calibrating the frequency of the oscillator, the instrument must be left connected to a power source for at least 24 hours. The oscillator runs when the instrument is in standby mode, so it is not necessary to have the instrument turned on during the warm-up period.

To perform the calibration, connect the 5 MHz or 10 MHz source to the Reference Input and initiate the calibration process from the service menu. The computer will determine the frequency of the external source then lock the internal oscillator to that source. After a stable phase lock has been achieved, the EFC voltage for the oscillator will be measured and stored. When the external source is removed the computer will set the EFC voltage to the stored value to maintain the set point.

4.3.2 Output Amplitude Calibration

There are three types of calibration associated with the amplitude control system. The first determines the relationship between the actual output power and the detector output voltage. Data is taken for each of the internal detectors and at each of the various gain settings in the input amplifier. The data is stored as coefficients to an equation, which describes the detector characteristic. The second set of data determine the relationship of the modulator input voltage to the change in output power. As with the detectors, data is developed for a set of coefficients used in a defining equation. The last calibration produces a table of correction coefficients as the frequency is varied over the operating range of the instrument

Power vs. Detector Voltage

For this calibration, the power sensor is connected from the power meter to the 12000A RF output, and the power meter IEEE 488 control is connected to an IEEE equipped computer. The test program supplied by Giga-tronics is now run. For each of the installed internal detectors (one is used for .01 to 2 GHz and another for 2 to 20 GHz) and for each gain range of the ALC input amplifier, the instrument will step the power and determine the relationship between the actual RF power and the dc input to the Analog-to-Digital Converter. This calibration is done at one frequency. The data taken develops a set of coefficients which are used in an equation that defines the shape of the detector curve.

Modulator Control vs. Applied Voltage

This calibration is essentially the converse of the previous one. Here the intent is to determine the relationship of the control voltage for the leveling modulator to the change in RF output power. A separate set of coefficients is developed for each octave.

Amplitude vs. Frequency Correction Factors

The last phase of the Amplitude Calibration sequence determines correction factors as the instrument is varied across its operating range. These correction factors compensate for RF path losses within the instrument and following the leveling detector. They also compensate for variations in the leveling coupler. During this test the instrument is set at a fixed amplitude and the frequency is stepped from the low to the high limit of the instrument.

4.3.3 Frequency Modulation Calibration

The calibration of the Frequency Modulation function is accomplished by using a known external source (the 1 Vdc supply) to measure various gains within the FM system. For this test, it is recommended that the external power source be connected to the FM input with a series resistor of approximately 500 Ω. This will provide about a 10:1 voltage divider (the FM input is 50 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V. For those parts of the test requiring a zero volt input, simply remove the connection to the FM input connector and the internal 50 Ω pull-down resistor will establish zero volts.

The FM calibration is divided into two parts, the low band and the high band. In the low band, the DDS portion may be directly calibrated since the DDS provides a fixed frequency increment for every accumulator set point bit increment. This allows calculating the multiplication coefficient for converting FM-ADC bits to DDS bits. Once the DDS is calibrated, it provides a precise shift in the loop control voltage. This voltage is null'ed using an internal voltage previously calibrated by the 1 Vdc source. The gains and offsets required to produce the null become the calibration factors for the high band.

4.3.4 Amplitude Modulation Calibration

The calibration of the Amplitude Modulation function is accomplished by using a known external source (the 1 V and 6 V supply) to measure various gains within the AM system. For this test, it is recommended that the external power source be connected to the AM input with a series resistor of approximately 6000 Ω for 1 volt and 600 Ω for 6 volts. This will provide about a 10:1 or 2:1 voltage divider (the AM input is 600 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V or 6.00 V as prompted. For those parts of the test requiring a zero volt input, simply remove the connection to the AM input connector and the internal 600 Ω pull-down resistor will establish zero volts.

Once the Amplitude Modulation system is de coupled, the application of the accurate 1 Vdc source allows the instrument computer to set the gain calibration to produce an appropriate shift in carrier power. Once this calibration has been done, application of a modulating signal will produce the proper depth.

4.3.5 Instrument Self Adjustment During Power Up

The following calibration adjustments are made each time the instrument is turned on:

YIG Oscillator Coarse Tuning Adjustment

Each time that the instrument is turned on an internal routine determines the setting of the YIG oscillator tuning DAC. The frequency is first set to 4.5 GHz and the DAC adjusted until the loop locks and the PLL voltage is approximately zero volts. This process is repeated at 7.5 GHz. Once the DAC settings for these two points are known, all other set points may be mathematically determined. This process insures that the coarse tuning for the oscillator is always optimized. It also allows replacement of the oscillator with no need to manually set up the tracking.

During CW and Step Sweep instrument operation the PLL control voltage is monitored by an ADC. If the voltage exceeds a narrow window around zero volts, the instrument computer automatically adjusts the coarse tune DAC in 1-bit steps to maintain the loop voltage within the window. This process occurs slowly and does not affect the instrument output. Use of this technique eliminates the possibility of unlock due to temperature variations or other drift causing mechanisms.

Tracking Filter Linearity

The tracking filter used in the synthesizer uses a wide range VCO whose tuning sensitivity varies considerably across its range. To maintain constant loop bandwidth, the loop gain is adjusted automatically as the frequency is varied.

ALC Offset

Another adjustment made each time the instrument is turned on compensates for any offset or zeroing errors in the amplifiers used for conditioning the detector outputs. Switching in the detector circuits removes the RF input of each of the detectors. An offset voltage is then summed into the input amplifier stage and the magnitude adjusted until the ADC output is near zero. This process is repeated for each gain range and each detector. The values are stored for use during leveling operation. These measurements are also taken at appropriate times during instrument operation to maintain the accuracy of the offset adjustment.

4.3.6 Mode Related Calibrations

Whenever this mode of operations is selected (as always, through the AM Menu) and the AM function is turned on, the instrument automatically performs a calibration of the modulator at whatever output frequency has been selected. Whenever either the frequency, power level, or both are to be changed, the preferred procedure is to switch the AM function off, make whatever frequency and/or power level changes are desired, then switch AM function back on. This technique provides the best possible accuracy for SCAN over its 60 dB range.

4.3.7 Factory Calibrations

ALC Temperature Compensation

To maintain accurate leveling operation over the specified temperature range, the instrument uses a set of data tables that are generated during normal instrument test. These data tables are a multi-dimensional array at various temperatures, levels, and detectors. There are sensors located adjacent to each detector to determine the temperature used by the computer for compensation purposes.

Series 12000A Microwave Synthesizers Data Sheet (Page 1 of 2)		
Serial Number:		Under Test Result record measured values (if any). In the case of a function check or range check, write OK to indicate that the unit under test meets specifications.
Date:		
Tested By:		
Quality Assurance:		

Frequency Range, Resolution, Accuracy		Test Result
4.2.2.3	12 MHz	
	24 MHz	
	48 MHz	
	100 MHz	
	200 MHz	
	400 MHz	
4.2.2.4	750 MHz	
	1500 MHz	
	3 GHz	
4.2.2.5	6 GHz	
	12 GHz	
	18 GHz	

Spurious Signals Tests		
Frequency (MHz)	Harmonics	Non-Harmonics
770.550		
1513.425		
4004.000		
9182.433		
17361.522		

Series 12000A Microwave Synthesizers
Test Data Sheet
(Page 2 of 2)

Serial Number:		Tested By:	
Date:		Quality Assurance:	

Single Sideband Phase Noise (dBc/Hz)

Frequency (MHz)	Offset from Carrier				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
1513.425					
4004.000					
9182.433					
17361.522					
23541.349					

RF Output Power		Test Result
	Max. Power Level	
	Power Level	
Step Attenuator test frequencies	1.0 GHz	
	4.0 GHz	
	12.0 GHz	
	17.0 GHz	

Pulse Modulation Tests

Frequency (GHz)	On/Off	Rise/Fall	Overshoot	Settling	Accuracy
1.0					
4.0					
12.0					
20.0					

Frequency Modulation Tests

Parameter		@1 GHz	@4 GHz	@12 GHz	@20 GHz
4.2.10.3	Deviation (5.7 - 6.3 div)				
4.2.10.4	Bandwidth (5 - 7 div)				
4.2.10.5	Bandwidth (4 - 8 div)				
4.2.10.7	Deviation (5.7 - 6.3 div)				
4.2.10.8	Bandwidth (5 - 7 div)				
4.2.10.9	Bandwidth (4 - 8 div)				

A

Accessories and Options

A.1 Introduction

The following accessories and options are available for the Series 12000A Microwave Synthesizers. Each accessory and option is described under its respective heading in this appendix.

Table A-1: Accessories & Options

Accessory/ Option No.	Description	Part Number	Field Installable
A001	Cable Kit (SMA)	29847	N/A
A002	Rack Mount with Slides	29901	Yes
A003	Rack Mount without Slides	29902	Yes
A010	Extra Operation Manual	31231	N/A
A011	Instrument Carrying Case	29855	N/A
20	High Power RF Output (+20 dBm)	29884	No
23	Type-N RF Output Connector	29891	Yes
24	Internal Modulation: AM, FM, Pulse	29890	Yes
26	Step Attenuator (20 GHz Instruments)	29882	No
28	5×10^{-10}/day Time Base	29883	Yes
36	1 kHz Frequency Resolution	29892	N/A

A.2 Accessories

A.2.1 A001: Cable Kit (SMA)

This accessory kit furnishes two coaxial cables (18 and 72-inches) with connectors for interfacing to user-supplied signal sources.

A.2.2 A002: Rack Mount with Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit includes mounting slides. The kit is available from Giga-tronics with part number 29901. The components included are listed below.

A.2.3 A003: Rack Mount without Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit does not include mounting slides. The kit is available from Giga-tronics with part number 29902.

A.2.4 A010: Operation Manual

Use part number 31231 to order additional copies of the instrument's Operation manual.

A.2.5 A011: Instrument Carrying Case

This is a special ruggedized carrying case for transporting the instrument between work sites. It can be ordered from Giga-tronics with part number 29855.

A.3 Options

A.3.1 Option 20: +20 dBm Output

If Option 20 is installed, the instrument maximum power specification is changed to be +20 dBm. This change is accomplished by adding a pair of amplifiers and a coaxial relay. The coaxial relay is used to either bypass the amplifiers (for set points below +11 dBm) or place them in the circuit when the power requested is +11 dBm or higher. The operation of the relay is automatic, based on the requested power unless high power is disabled. The ALC menu has an entry for high power that allows either Automatic operation or disable mode.

The table below lists the specifications that are changed when option 20 is active. Specifications apply from 0° to 35° C.

Flatness	± 2.5 dB
Harmonics	< -5 dBc, 0.1 to 2 GHz
	< -20 dBc, 2 to 20 GHz
Pulse on/off ratio	≥ 60 dB
AM	Functional, but not specified above 0 dBm

NOTE: *Due to the losses in the relay and the extra cables, the maximum power of the instrument with Option 20 disabled is 2 dB less than the standard instrument specification.*

A.3.2 Option 22: Rear Panel RF Output Connector

If Option 22 is installed, the RF output connector is relocated to the rear panel of the Series 12000A. Option 22 can be installed with or without Option 26.

A.3.3 Option 23: Type-N RF Output Connector

If Option 23 is installed, the RF output connector is changed to Type N.

A.3.4 Option 24: Internal Modulation, AM and FM Modes

This option provides two built-in function generators for creating AM, FM and pulse envelopes.

This option has been incorporated into the main body of the manual; where a procedure or specification applies only to instruments with Option 24, a note to that effect is included.

A.3.5 Option 26: 10 dB Step Attenuator

Under this option, an attenuator is placed in the RF output path of the instrument, which provides up to 110 dB of attenuation in 10 dB increments.

This option has been incorporated into the main body of the manual. Where a procedure or specification applies only to instruments with Option 26, a note to that effect is included.

A.3.6 Option 28: High Stability Timebase

When Option 28 is installed, a special timebase oscillator having an aging rate of 5×10^{-10}/day is substituted for the standard timebase oscillator.

A.3.7 Option 36: 1-kHz Resolution

If Option 36 is installed, the frequency resolution of the instrument is 1 kHz.

B

Firmware Field Upgrade

B.1 Introduction

This appendix describes the process by which a model 12000A synthesizer may have its application firmware upgraded using a straight-through RS-232 cable. The following components are necessary:

- A PC running Windows 95, 98, or NT 4.0 with a free serial COM port.
- ***HyperTerminal™*** (A communications program that is included with Windows 95/98/NT).

> ☛ ***NOTE:*** *It may be necessary to install the HyperTerminal™ program from the original Windows 95/98/NT CD-ROM if it has not been already installed on your computer.*

- A DB9 male-to-female, straight-through RS-232 cable.
- A checksummed binary file of the desired synthesizer firmware downloaded from **www.gigatronics.com**, then downloaded to the Series 12000A. The file is typically called **12000.chk**.

B.2 Procedure for Firmware Versions V073 or Greater

1. Start with the Series 12000A powered **OFF**.
2. Start your PC and go to **HyperTerminal™** *(see Figure B-1)*.

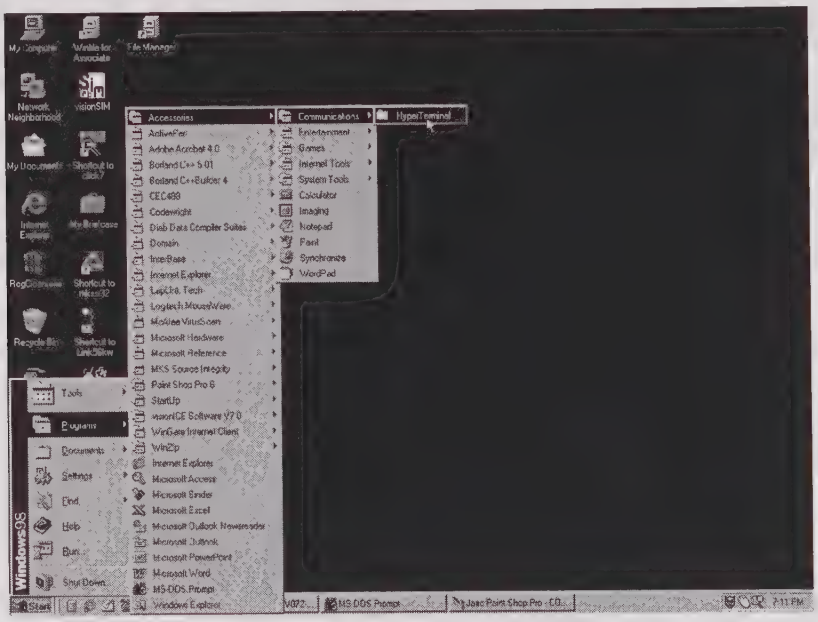

Figure B-1: Selecting HyperTerminal

3. If you have not created a HyperTerminal connection for download purposes previously, select HYPERTRM.EXE (see Figure B-2).

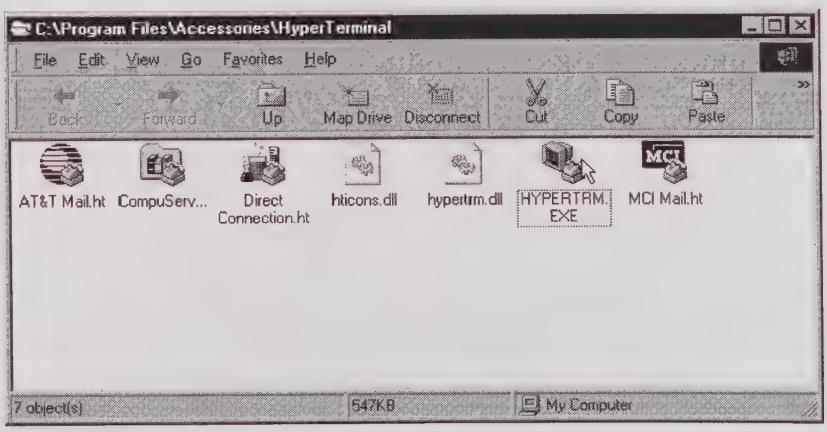

Figure B-2: HYPERTRM.EXE

4. If you are creating a new connection, give it a name as shown in Figure B-3.

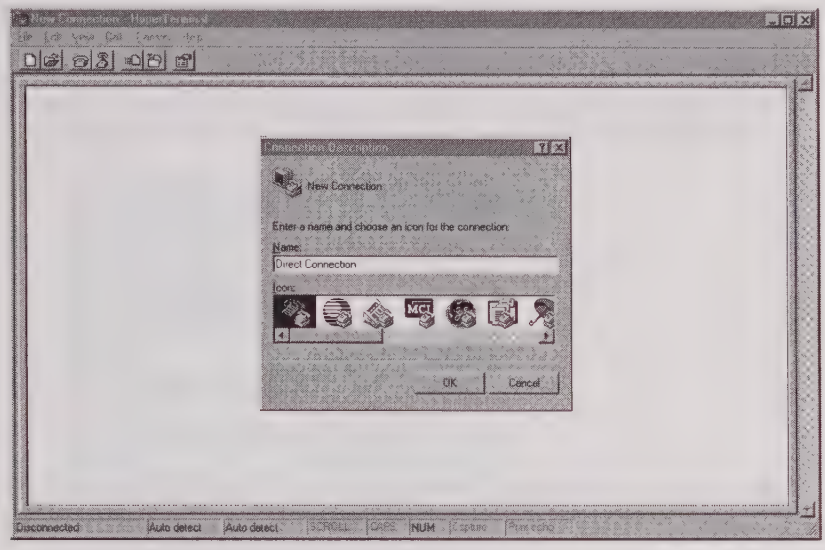

Figure B-3: Assigning New Connection Name

5. Select a "direct" connection to the COM port that is available to be used for downloading. (See Figure B-4 for an example).

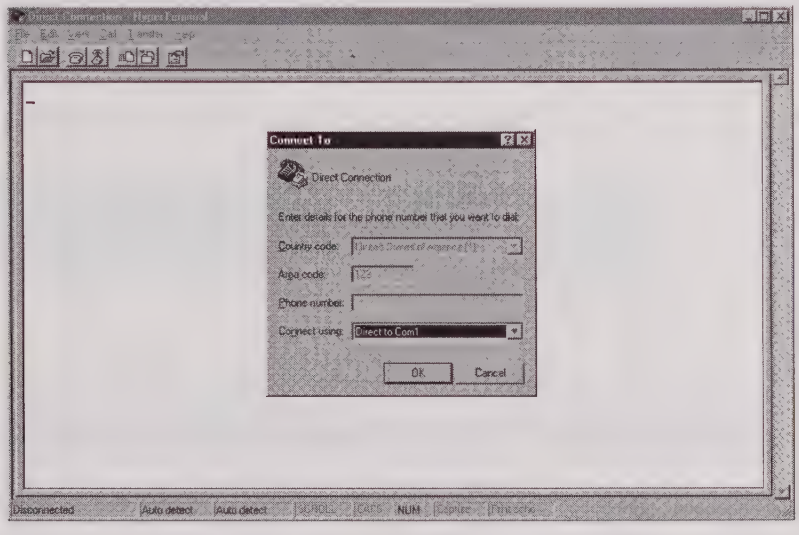

Figure B-4: Direct to Com1

6. Set the port parameters for 9600 baud, no parity, 8 data bits, 1 stop bit, and no flow control, as in Figure B-5.

☛ ***NOTE:*** *Use a baud rate compatible with your computer.*

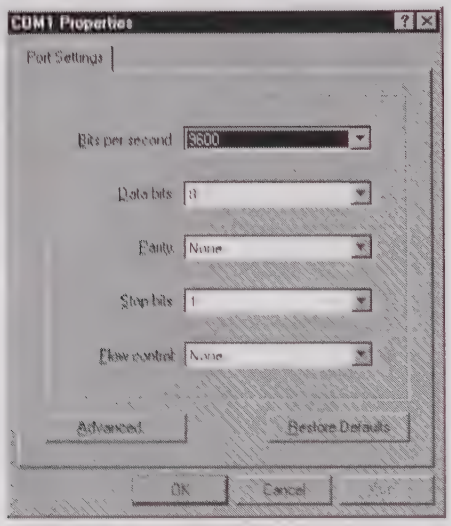

Figure B-5: Port Parameters

7. Connect the RS-232 cable from the COM port of the PC to the rear of the Series 12000A.

8. Click on the **Call** or **Connect** button on the toolbar as shown in Figure B-6.

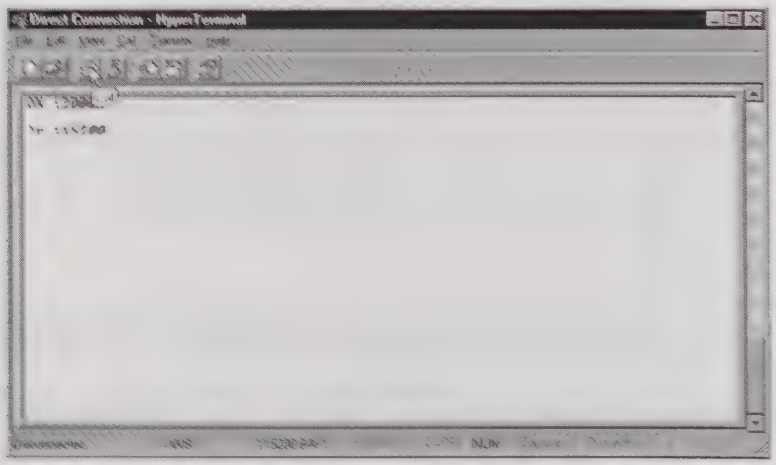

Figure B-6: Call or Connect Selection

9. Turn on the Series 12000A.

10. As the Series 12000A is initializing, press the "*" (asterisk) key on the PC.

11. Wait for the "OK 12000A" message to appear in the HyperTerminal window as shown in Figure B-7.

Figure B-7: 12000A Initializing

12. Type "**E1**" and press the **Enter** key. The Series 12000A should respond with a "**>**" prompt (see Figure B-8).

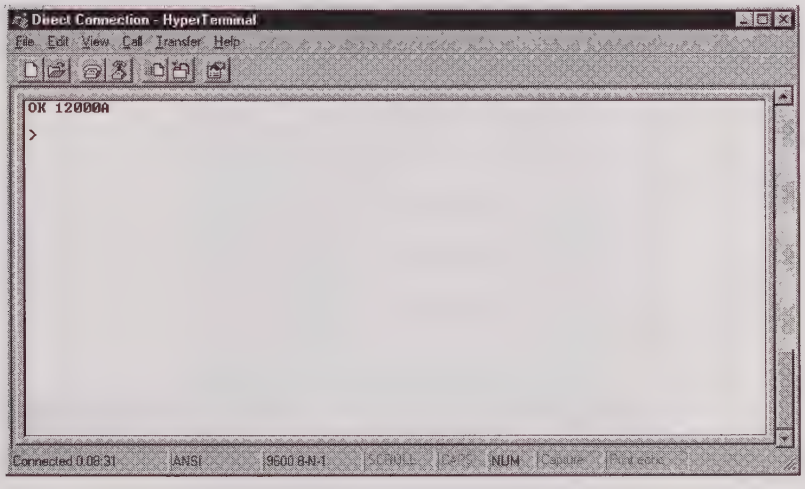

Figure B-8: 12000A Prompt

13. Change the baud rate by typing "**R 115200**" and press the **Enter** key. Note the Series 12000A will not respond.

☛ ***NOTE:*** *Use a baud rate compatible with your computer.*

14. Click on the **Disconnect** button on the toolbar as shown in Figure B-9.

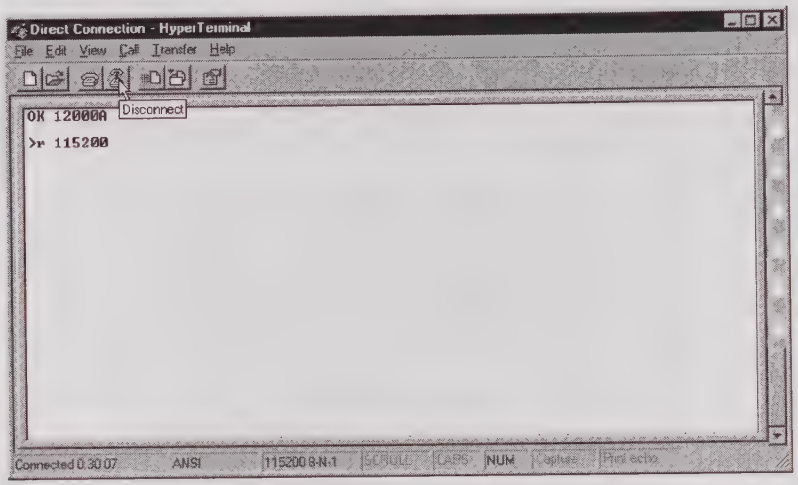

Figure B-9: Disconnect from HyperTerminal

15. Click on the **Properties** button on the HyperTerminal toolbar as shown in Figure B-10. This will open a Properties page.

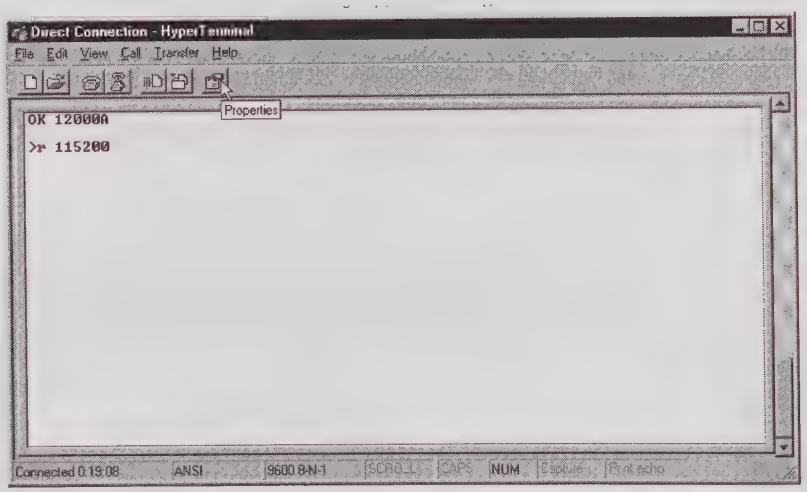

Figure B-10: Properties Selection

16. Click on the **Configure** button shown in Figure B-11.

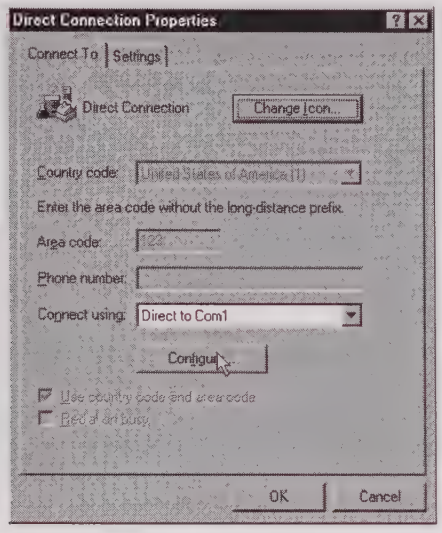

Figure B-11: Configure Selection

17. Set the Bits per second to **115200** and then click on the **OK** button (see Figure B-12).

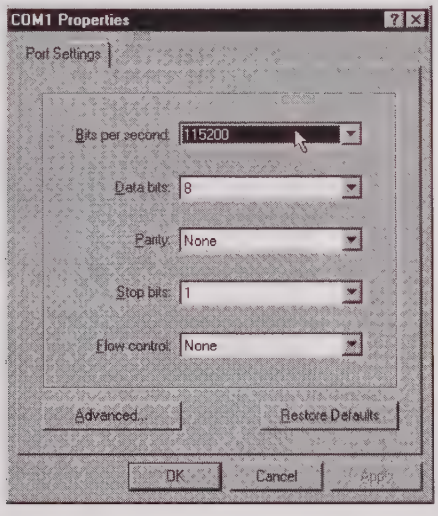

Figure B-12: Bits Per Second Selection

18. Also click on the **OK** button of the Properties panel shown back in Figure B-11.

19. Click on the **Call** or **Connect** button on the toolbar as shown in Figure B-13.

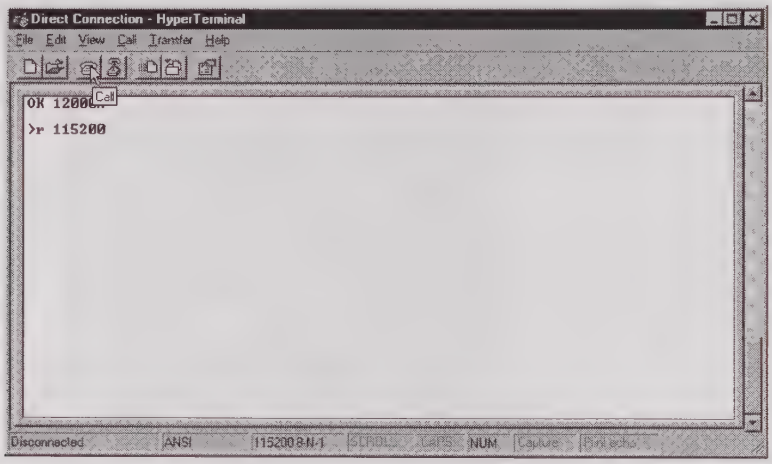

Figure B-13: Call or Connect Selection

20. If you press the **Enter** key, you will get a "**>**" prompt, verifying that the PC is communicating with the Series 12000A at 115200 bps.

21. To send the application file to the Series 12000A, type "**X**" and press the **Enter** key. You must now quickly perform the next step before the Series 12000A times out.

22. Click on the **Send** button on the toolbar and make sure that the Protocol is set for **1K Xmodem** as shown in Figure B-14.

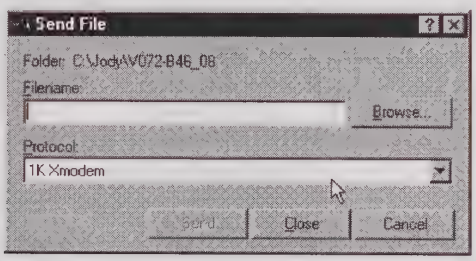

Figure B-14: Send File

23. Either type in the filename or use the **Browse** button to locate the application firmware file, then find the 12000.chk file and click **Open**.

24. If you did not begin the file transfer quickly enough (approximately 50 seconds), you may press the **Enter** key and try again at Step 22, otherwise the selected application file will be downloaded to the Series 12000A after a brief delay as shown in Figure B-15.

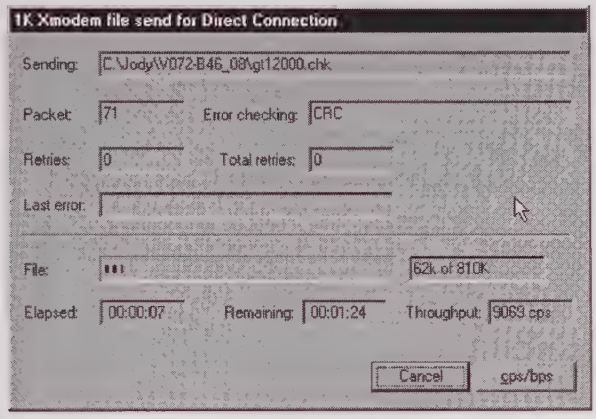

Figure B-15: Application File Download Selection

25. After the transfer is complete, you should get an "**OK**" with no other characters preceding it, followed by a "**>**" prompt as shown in Figure B-16.

Figure B-16: After Transfer Completion Prompt

26. Type "**Y**" and press the Enter key. You should get an "**OK**" followed by a "**>**" prompt. If not, redo the file transfer from step 22.

27. Type "**Z**" and press the **Enter** key to program the application FLASH memory. You should get an "**OK**" followed by a ">" prompt after about a minute.

28. Type "**H**" and press the **Enter** key to boot the Series 12000A. The software version displayed on the Series 12000A screen should correspond to the firmware that you have downloaded to the unit.

29. Cycle the power on the Series 12000A to ensure that FLASH was programmed correctly.

B.3 Procedure for Firmware Versions Less than V073

If your 12000A has a firmware version V072 or earlier, you must upgrade your boot code by installing a special version of 12000A software prior to the desired upgrade. The version label for this firmware is V072-BOOT-UPGRADE-2 and can be obtained from Giga-tronics, Inc.

Follow the instructions in section B.2 for installing a new firmware upgrade selecting the special BOOT-UPGRADE version when prompted for a file name. Complete the process and allow the 12000A to boot fully. BE SURE TO ALLOW THE 12000A TO COMPLETE THE ENTIRE BOOT PROCESS OR THE BOOT CODE MAY NOT BE UPGRADED PROPERLY. After you have loaded this special version, repeat the process for your new upgrade version.

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Oxford

RV-1WE	WHITE
RV-1BK	BLACK
RV-1RB	ROYAL BLUE

MADE IN THE U.S.A.

ESSELTE

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MICROWAVE SOURCES

SWEEPERS

SIGNAL GENERATORS

POWER METERS

SCALAR ANALYZERS

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